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SPELLING AND MORPHEME RECOGNITION: A METHODOLOGICAL STUDY

by

MARTHA L. SMITH

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A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF SCIENCE
IN
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DEPARTMENT OF LINGUISTICS

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SPRING, 1987

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(SIGNED) M. L. Smith

PERMANENT ADDRESS:

Box 578
Castor, Alberta
TOC OXO

DATED April 21 1987

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FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled SPELLING AND MORPHEME RECOGNITION: A METHODOLOGICAL STUDY submitted by MARTHA L. SMITH in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE in PSYCHOLINGUISTICS.

Bruce L Derwing

Supervisor

Wm. J. Baker

Thomas E. Campbell

Tom M S Priestly

Date April 21, 1987

To all those who have contributed to my education
and encouraged me along the way.

Abstract

This study investigated the role of spelling knowledge in morpheme recognition (MR), or the perception of morphological relationships between "derived" words and their putative roots. Two overlapping sets of 11 words each, illustrating a variety of morphological constructions (e.g., *awful, fabulous, creature, criminal, decision, knowledge, cupboard*), were selected as stimuli. One set was presented to a group of 48 subjects in Grades 4-5, the other to a second group of 48 in Grades 6-7. To assess MR, a new "enhanced" questioning technique was developed, incorporating elements from the prior work of Berko (1958) and Derwing (1976). Three alternative systems were also devised for scoring the MR data and the usefulness of each scoring system was assessed, as well as suggestions made for a best, abbreviated "all-purpose" test. For each of the 19 stimuli, MR comparisons were made between the subjects who had made spelling errors on the critical "root" components of the stimuli and those who had not, and it was found that, for a number of items, the differences were statistically significant. It was concluded that, depending on the nature of the stimulus item, knowledge of the spelling can be an important contributor to MR, especially in cases where morphological relationships are less than clear on the basis of phonological and semantic information alone (as in the words *cupboard, necklace, drawer* and *knowledge*). The study also provided evidence that some word pairs (such as *fabulous-fable*), commonly thought to be morphologically related by linguists, are not perceived as related by ordinary subjects, although, as noted above, awareness of morphological relationships can be greatly enhanced by such educationally derived knowledge as knowledge of particular spellings. Literacy and educational experience are thus potentially important contributing factors in the development of normal adult linguistic competence.

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1. INTRODUCTION

> We often think that when we have completed our study on one, we know all about two, because 'two is one and one'. We forget that we have still to make a study of 'and'.
>
> \- Sir Arthur Eddington

1.1 PRELIMINARIES

The past several decades have witnessed the development of a field of study known alternately as "experimental linguistics" or "psycholinguistics" (see Derwing 1973:301-307 regarding some misleading implications of the latter term). A central goal of this area of inquiry is to discover and characterize the knowledge which a speaker has about his language. In contrast to the structural linguist who essentially attempted to describe the language product, psycholinguists are primarily concerned with understanding the mental states and processes which are involved in acquiring, comprehending and producing language. The knowledge which a speaker has when he can be said to "know" a language is often refered to as "tacit" or "unconscious" knowledge which is nonetheless "psychologically real." This latter term, although generally adopted, is rarely defined and appears to be bandied about rather freely within the field; most uses of the term would seem to fit into the general definition given above although, usually, the notions of "linguistic generalization" and "productivity" are also invoked. Cena (1978), addressing several questions concerning the issue of psychological reality, suggests that a phonological generalization is psychologically real if it "serves as a variable in mental processing" (p.2). Along with a performative interpretation of psychological reality, Cena reaffirms the traditional notion (apparently ignored by a number of researchers) that "psychological reality is a matter of degree." In other words, "psychological reality or productivity is a gradient phenomenon" since "certain generalizations are more psychologically salient than others" (p.29). Jaeger (1979) uses a "purely functional" definition of the term which "does not implicate any particular linguistic or cognitive theory." In her conception, "a linguistic entity or phenomenon is psychologically real if it can be shown to guide or influence speakers' linguistic behaviour" (p.20). She also notes that "there is no particular meaning of this term which is accepted by all linguists or all theories" and that "psychological reality is not an all-or-nothing proposition." In other words, "it is likely that things which speakers know about their language are arranged hierarchically, with some phenomena being more important or salient than others, and therefore probably more general and productive" (p.20).

Whatever the definition employed (and whether it is explicit or implicit), psycholinguists appear to agree on one thing: the identification of this "psychologically real knowledge" is imperative if we are to understand or explain anything about the processes involved in human language behaviour. One of the prime pursuits of psycholinguists, then, is to identify this knowledge since, as Jaeger (1978) notes, it is necessary to know what is psychologically real before reasonable hypotheses can be made about how or why it came to be "psychologically real" for any speaker or group of speakers.

In the quest to uncover the "truth" about what knowledge may be psychologically valid, linguists have typically downplayed or ignored the role of written language. There are historical reasons for this (which will be explored briefly in Section 2.2), although the main reason is a simple recognition and whole-hearted embracing of the obvious fact that all normal people learn to speak before they learn to write (and that speaking ability is acquired almost without exception while writing may never be mastered). This observation has led many linguists to accept the view of written language as a mere "reflection" of the primary spoken form. Along with this speech-based perspective of language learning, the traditional assumption has been (as Jaeger, 1984, notes) that "speakers' unconscious knowledge about their language is derived solely from hypotheses formed during pre-literate language acquisition" (p. 34). As a consequence of these views and assumptions, there seems to have been consensus among many linguists that orthographic knowledge has little formative influence on speech and, hence, whatever influence it may have on speakers' judgements or intuitions should be regarded mainly as a "nuisance" factor in linguistic investigations. The unstated implication of this position is that the sum of a speaker's "psychologically real" linguistic knowledge is acquired before exposure to the written form of the language and that speakers either do not, or can not, acquire "psychologically real" knowledge from written language input.

In recent years, a number of linguists and cognitive psychologists have taken a different perspective (educators have always seen things differently) and begun to investigate the role of orthographic knowledge in psycholinguistic experimentation. To date, most of the research in this area has focused on the influence of orthography on phonological judgements (some of this research will be discussed in Section 2.2.1). Much of this experimentation grew out of the debate on the psychological status of the vowel shift rule as hypothesized in Chomsky and Halle's very influential book The Sound Pattern of English (1968; henceforth SPE). Aside from this "core" of research, however, there is a significant body of recent literature documenting studies which also attest to the possibly significant role that orthographic knowledge may play in determining what a speaker knows about his language. These studies suggest the same general conclusion which Jaeger (1984) reached; namely, that "certain entities can be psychologically real either because they have been brought to the speakers' conscious attention as part of their education or because they have been intuited from the orthographic system of their language" (p. 34).

Jaeger's conclusion as stated above would not seem to be unreasonable. To discover what is "psychologically real" for native North American English speakers, it would seem to be important to consider the speakers' sources of linguistic knowledge. Obviously, spoken language input is the primary source and speakers' experiences with the written source will be subject to a great deal of variation. However, the fact that we live in a society where literacy is highly valued and widespread cannot be totally unimportant; the average speaker can hardly avoid exposure to the written form of the language. This experience with the written language usually begins at an early age, since schooling is compulsory and children begin learning to read and write while they are still undergoing cognitive (and presumably linguistic) development. While the hypotheses formed prior to exposure to the written language may be of a more general and productive (and, therefore, more "rule-governed") nature, it does not follow, a priori, that this is the only type of knowledge which is "psychologically real" (and, therefore, worth studying seriously in a psycholinguistic sense). It is quite possible that the linguistic knowledge which is psychologically real to native literate speakers is the "and" between hypotheses formed during preliterate language acquisition and the knowledge which is educationally derived (such as knowledge of the English orthographic system), although the former may be more important than the latter. This idea is not new and may even seem, to the layman at least, to be a notion so obvious that it is hardly worth putting in writing. It is surprising, therefore, to discover that linguists in the past half century or so have focused almost exclusively on speech — both in terms of describing the "true" language *product* and in terms of trying to discover the *processes* which go on in language users' minds.

There are notable objections and exceptions to this viewpoint, however. Bolinger, writing in 1946, argues that "visual morphemes exist at their own level, independently of vocal-auditory morphemes" and concludes that "it is probably necessary to revise the dictum that language must always be studied without reference to writing". Although he agrees that the dictum may be applied "to all languages at some stage of their development and to large illiterate speech communities today", he urges the recognition of "a shift that has taken place in the communicative behaviour of some highly literate societies" (Bolinger, 1946:340).

Arguments such as those put forth by Bolinger, however, have not made much impact on the field of linguistics. Until the last decade or so, very few linguists were concerned with theoretical questions concerning the nature of the English writing system, its relationship to other subsystems of the language and the issues these questions might raise about the nature of the speaker's knowledge of his language. Most literature on the topic, in fact, is found in the fields of education and psychology where considerable fruitful research has been produced. Templeton (1979), for example, investigated the way in which orthographic and phonological knowledge interact in the older student. His introduction serves to illustrate the orientation of some of this research.

> The interplay between the spelling system of English and the knowledge of English sound structure that individuals possess has been an intriguing area of investigation for both psychologists and educators (e.g., Steinberg, 1973; Read, 1975). The question most often addressed in the research involves the degree to which knowledge of orthographic structure influences the psychological reality of words and the phonological processes that apply to them. The question is an important one, for it is part of a broader concern involving the way in which individuals organize information about the vocabulary of English. In effect, there probably are limits to the amount of information about words that individuals can be expected to glean from spoken language; the rest of the information may arise from an examination of orthographic structure.
>
> (Templeton, 1979, p.255)

On the basis of his research, Templeton concluded that "a productive knowledge of orthographic structure may often precede higher order phonological knowledge" [like vowel alternation] and that "orthography, being a more stable, visually-accessible system, may thus become the basis for a logical analysis of word-level phonology and semantics" (p.263).

Templeton's conclusions, while only tentative, are reminiscent of some statements set forth by W. N. Francis a decade earlier. In considering the role of writing systems and the question of the nature of a speaker's knowledge of his language, Francis suggests that a speaker's linguistic knowledge will be influenced or determined by his condition of either literacy or illiteracy and the role which writing plays in his society. He notes that "the role of writing — socially and hence linguistically — may cover a wide range, from the almost completely peripheral position held by runic writing in early Germanic to the overwhelming importance of print in a modern industrial society". In the former case, "the integration of writing into the polysystematic structure of language is incomplete and its position marginal" and, hence, by implication, not likely to influence the native speaker's linguistic intuitions. It may be, however, that "those languages that have writing systems are different in important ways from those that do not and, hence, that the linguistic knowledge of a literate speaker of such a language is different in kind from that of an illiterate speaker of the same language, as well as from that of a speaker of a language without a writing system" (Francis, 1970, p.46).

Francis' intuitively plausible conclusion, however, is unfortunately not one that is easily investigated empirically. Although cross-linguistic studies or studies with illiterates and pre-literates might add insights, such studies are bound to be fraught with all manner of uncontrollable variables and practical difficulties. For example, even though recent statistics claim that an estimated 4 million adult Canadians are functionally illiterate,[1] it would be no easy task to identify and work with some "uniform" group. In any case, these are probably not illiterates who have no knowledge of the English writing system (or some writing system); they are presumably immigrants or people who have "dropped out" or "slipped through the cracks" of the existing educational system.

In spite of the objections to such research and the difficulties inherent in any serious attempt to address questions regarding the role of orthographic knowledge in influencing linguistic judgements, the issue should not be ignored. Most psycholinguistic research utilizes subjects who are either literate or in the process of becoming literate. If the goal is to understand and explain the linguistic knowledge and abilities of such native speakers, it may be important, as Jaeger (1979) suggests, for psycholinguists to "try to sort out intuitively acquired linguistic behaviour from education-derived behaviour, but not [to] be afraid to consider both as potentially psychologically real" (p.19). This is, granted, a formidable task. Nevertheless, it is a topic worthy of research. If knowledge gained with exposure to (and instruction in) a writing system makes no substantial contributions to, or does not affect, a speaker's "psychologically real" linguistic knowledge, then this conclusion should be substantiated with empirical evidence. A priori assumptions about the realm from which speakers can acquire "true" linguistic knowledge (inherited from linguistic traditions of notably different goals and orientations) do not constitute a solid foundation on which to build a science. It would seem important to identify and examine our assumptions before they are confidently used as a foundation on which to construct paradigms for future investigation. The point being made here is that it is not enough to relegate any linguistic phenomena associated with the "orthographic variable" to mere "interference." At the very least, it would seem important to recognize that literacy may contribute something to a speaker's linguistic knowledge. Further than this, some attempt should be made to determine what this "something" may be and to clarify the questions concerning the psychological status of this knowledge and the role it may play, if any, in the overall picture of human language processing.

---

[1] Reported on "The Journal" (CBC), July 22, 1986.

1.2 GOALS OF THE STUDY

This study attempts to gain some insights into that aspect of linguistic knowledge which is gained through exposure to the written form of the language. The basic premise adopted is as follows: If, as recent studies have shown (see Section 2.2), educationally derived knowledge (such as knowledge of English orthography) can be influential in determining or affecting speakers' phonological judgements, it is possible that this knowledge may also play a role in shaping other linguistic intuitions. It is plausible, for example, that there may be some relationship between a knowledge of particular spellings and a recognition of certain morphological relationships between words. Conversely, a perception of derivational relations may play a role in the learning of spelling — or lead to misspellings. To date, this topic has been the object of very little empirical research. One of the reasons for this is the current state of psycholinguistic knowledge in the area of derivational morphology. "Morphology is inherently messy" (Hooper, 1979:113) and, according to Lightner (1968) and Derwing (1976), derivational morphology is one of the most difficult and least studied of all the areas of linguistic description. There are, of course, reasons which may be responsible for this. The first problem is that there is no clear and principled way to decide when words can be said to share a common morphemic unit — at least in the minds of naive native speakers (this problem and others are discussed more fully in Derwing, 1976). Along with the unanswered theoretical questions are the methodological problems of tapping the appropriate type of knowledge. How, for example, does one assess which morphological relationships are "psychologically valid" for any given subject or set of subjects? To date, very little experimental investigation has dealt with this question.

The above problems and questions provide the rationale and motivation for this thesis. Essentially, this study has two goals. The primary goal is to investigate the role of spelling knowledge in morpheme recognition. While this is the primary interest of the study, the secondary goal is logically prior to its investigation. It is essential to have some research tools such as tried-and-tested methodological techniques before an investigation can be conducted. In the case of investigating speakers' knowledge of derivational relations, these necessary methodological tools are notably lacking. To date, no established techniques exist which can reliably be used to address the question of whether potentially relatable words are, in fact, psychologically related for naive native speakers. This thesis presents and utilizes a methodology for probing native speakers' intuitions about various word relationships. The technique introduced here builds upon previous work done on morpheme recognition (see Section 2.4.2) and attempts to integrate and evaluate aspects of the various approaches. The results of the morpheme recognition task are compared to subjects' spelling productions. This thesis, then, is a preliminary investigation into the possible role of spelling knowledge in morpheme recognition. It should be clear, however, that while the concerns of this thesis go beyond methodology, the study is necessarily a methodological investigation of an exploratory nature.

1.3 OVERVIEW

Chapter Two consists of a review of literature related to the concerns outlined above. A first section outlines some of the psycholinguistic research which has been concerned with the "orthographic variable." Since the present experiment is concerned with both spelling production and morpheme recognition, literature on the topics of English orthography and derivational morphology is also reviewed. Chapter Three describes the experimental procedures and presents the results. In Chapter Four the main findings of the experiment are summarized and discussed. Limitations of the study and implications for future research are also considered.

2. REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

This chapter is devoted to a review of literature which is related to the goals of the study as outlined above. No clear division between experimental and theoretically oriented literature is observed in this review. Three major topics are addressed and empirical studies which are relevant to these topics are considered whenever possible.

The first major section is concerned with orthography in psycholinguistic investigations. Since most of the empirical work has been done in the area of experimental phonology, a sub-section has been devoted to reviewing some of these studies. Two other major sections are concerned with the topics of English orthography and English word formation respectively. The former section is intended to give some insights and information which may be important to consider when dealing with subjects' spelling productions. The latter section identifies some of the problems of morphological investigations and also outlines the pioneer work which the morpheme recognition task presented in this study is based upon. The topics addressed in the three sections are independent on one level but are all critically related to the central concerns of the thesis as outlined in Chapter One.

2.2 ORTHOGRAPHY IN PSYCHOLINGUISTIC EXPERIMENTATION

The traditional domain of inquiry for the North American linguist has been chiefly "spoken" rather than "written" language. While the influence of orthography on language has occasionally been recognized (usually in a historical context with respect to language change, borrowings, preservation effects, etc.), most linguists have regarded the written form of the language as secondary, uninteresting, or even irrelevant to the "true" study of language. There seems to have been a consensus among many linguists that orthography has little formative influence on speech and, as a consequence, its influence on speakers' judgements or intuitions has often been downplayed or regarded mainly as a "nuisance" factor which confounds the "proper" speech-based perspective of language learning and actual pronunciation. According to Ehri, "most linguists are not much interested in writing" and, in fact, "many do not consider it a topic of study in linguistics since it is not language but only a reflection" (1984, p.121). This particular orientation has a long and honorable history in North American linguistics; its influence can be found (especially) in the era of Bloomfield's "autonomous" linguistics. It may prove instructive to look back to the roots of this linguistic perspective.

The notion that spoken language is the sole appropriate domain for linguistic inquiry dates back to the 19th century and appears to have developed largely as a reaction against the then current practice of focusing almost exclusively on written language for linguistic analysis (cf. Haas, 1970, pp.12-15). According to Coulmas (1986), "until the 19th century, it was common practice to look at writing instead of speech as the data of linguistic analysis.... The advent of Structuralism brought the shocking discovery that linguists had been wasting their time for the past two thousand years, because they had studied writing which was actually a record of speech only. Speech should, therefore, be considered the sole object of linguistic investigation. As a consequence, modern linguistics since de Saussure has ... paid lip-service to the primacy of the spoken word" (pp.1-2). In a similar vein, Venezky (1970) notes that "the first twentieth century linguists were so adamant in pointing out the nineteenth century confusion of sound and spelling that they reduced the orthography to a secondary, subservient role from which it has infrequently emerged in the writings of contempory linguists" (p.25).

Vachek (1973) claims that "the latter half of the nineteenth century, as well as the first three decades of the twentieth, showed very little understanding for written language viewed as a system 'in its own right' (at least, partially so)..... The dominating idea of linguistics in the said period is the absolute supremacy (one might say, 'linguistic legitimacy') of the spoken language and of the acoustic make-up of spoken utterances. The era of flourishing research in phonetics (mainly the last quarter of the nineteenth and the first quarter of the twentieth centuries) could not but look down upon the 'unphonetic rendering' of the sentences of a language by means of what was generally called the 'conventional spelling' to which one opposed the 'scientifically exact phonetic transcription'" (pp. 9-10).

One of the more outspoken proponents of a linguistics that focused exclusively on speech was Leonard Bloomfield, who is commonly acknowledged as the "father of modern American descriptive linguistics". While Bloomfield did admit that orthography could influence the spoken language, he is usually credited with being one of the more influential linguists who expounded the belief that written language is merely a passive recipient of speech. In his words:

> [W]riting is not language, but merely a way of recording language by means of visible marks... A language is the same no matter what system of writing may be used to record it... In order to study writing, we must know something about language, but the reverse is not true.
>
> (Bloomfield, 1933:21)

According to Vachek (1973), Bloomfield's view of language "was to become, for a long time to come, part and parcel of American linguistic ideology" (p.11).

While it is no doubt unfair to take Bloomfield's comments and arguments out of their historical context, it seems clear that this speech-based perspective of linguistic description and investigation has generally prevailed during the history of linguistics in North America and that some credit is due to Bloomfield for this orientation. What it is important for psycholinguists to note, however (particularly those coming from linguistic rather than psychological schools of thought), is that Bloomfield's goals and focus of interest were expressly NOT psycholinguistic. Psycholinguists are fundamentally interested in language processing and, hence, their investigations are crucially tied to the study of the psychology and physiology of the language user (cf. Derwing and Baker, 1976). Bloomfield set notably different goals and limitations to his study of language. He was primarily interested in linguistic forms and explicitly stated that "in the division of scientific labor, the linguist deals only with the speech signal..., he is not competent to deal with problems of physiology or psychology" (1933, p.32). Bloomfield's views on language, then, may have been quite appropriate for his stated domain of study; it does not follow that Bloomfield's speech-based orientation can be safely adopted by the psycholinguist. The linguistic literature of the past half century, however, suggests that Bloomfield's speech-based perspective of language (and language learning) has been faithfully transmitted (without serious questioning) beyond the era of Structuralism, through the "psychological" revolution ignited by Chomsky and into the field of study presently known as "psycholinguistics".

Although the idea that writing does not just duplicate speech (or is not just a "reflection" of language) has become increasingly widespread and generally accepted, there is an even more fundamental distinction at stake here. According to Derwing and Baker (1976), it has been the case that "...somehow, between Bloomfield's declaration to free linguistics from psychological entanglements and Chomsky's call to re-instate linguistics as a branch of cognitive psychology, a serious and all-comsuming confusion has arisen between language as a product and language as a process" (p.14). Psycholinguists in the past several decades have clarified this distinction and emphasized that their concern is with language processing. The priority question then, is not the real issue at all. Obviously, speech is primary both in terms of being the first language product speakers are exposed to and in terms of the processes they will first employ in comprehending and producing the product themselves. Native literate speakers, however, have also had exposure to the written language product as well as explicit instruction in the process of becoming literate. Traditionally, research into the processes involved in learning to read and write has been the domain of educators and cognitive psychologists and, while a great deal of fruitful research has been conducted, the orientation of this literature is towards improving instruction and understanding reading and writing disabilities rather than addressing "linguistic" questions per se. For psycholinguists who are interested in understanding and explaining the linguistic knowledge and abilities of native literate speakers, some fundamental questions remain unanswered (and even unaddressed). Some of these questions could be formulated as follows: How do the processes involved in achieving literacy interact with the processes employed in pre-literate language behaviour? What is the consequence of learning to read and write (two different skills which may involve significantly different strategies and processes) on linguistic judgements in general? What effect does spelling knowledge have on lexical representations? What effect does orthographic knowledge have on phonological judgements? Does learning how to spell influence the ability to recognize morphemes? Can the boundaries of intuitively acquired and educationally derived knowledge be delineated and, if so, what is the psychological status of the latter? Is it appropriate to classify linguistic behaviour associated with "the orthographic variable" as "interference"? Why or why not? Empirical research which addresses these questions is still in the infant stages in the field of psycholinguistics. This research has been almost exclusively concerned with the area of phonology. The next section outlines some of the research which has lead to insights into these concerns.

2.2.1 ORTHOGRAPHY IN EXPERIMENTAL PHONOLOGY

Experimental linguistics (psycholinguistics), as an interdisciplinary area of inquiry, draws its practitioners from two major fields of study: linguistics and psychology. For the linguistically trained psycholinguists, the "orthographic variable" emerged, it may be said, "by way of the back door." A good deal of relevant research, for example, grew out of the experimentation designed to test the psychological reality of the Vowel Shift (VS) Rule proposed by Chomsky and Halle (1968). This VS Rule (which was formulated with considerations of maximum simplicity and economy) was intended to account for the phonological relatedness exhibited by pairs of vowels in (formally speaking) morphologically related constructions such as ***divine-divinity*** [ay-I], ***serene-serenity*** [iy-ɛ], etc. The motivation for this rule was entirely phonological and it was described as being "without doubt the pivotal process of Modern English phonology" (SPE, p.187).

While the phonological descriptions of SPE were an impressive exposition of sound patterns which could be shown to occur in the language as well as a brilliant and economic recapitulation of historical processes such as the Great Vowel Shift (cf. Vachek, 1973, p.68; Francis, 1970, p.48; Bauer, 1983, p.129), it was the claims for the psychological reality of this rule which lead to fruitful controversy and experimental research in the linguistic community.

In essence, Chomsky and Halle formulated a system of rules and then asserted that there was a correspondence between the formal constructs and the actual internalized "grammar" of the speaker-hearer. Interestingly, although this knowledge of phonological alternations was presumably gleaned from exposure to the spoken language, it was claimed that the very abstract underlying phonological representations which were posited bore an intimately close relationship to English orthography. In their words, "there is, incidentally, nothing particularly surprising about the FACT (emphasis added) that conventional orthography is ... a near-optimal system for the lexical representation of English words" (p.49).

While one must be careful not to imbue these words with meanings which Chomsky and Halle did not intend, it does seem highly unlikely that children (on the basis of exposure to the spoken forms alone) would acquire underlying representations that are so systematically similar to conventional orthography. In the final analysis, such a theory could only be an appropriate description of the knowledge of an "idealized speaker" who would necessarily have to be literate (and no doubt fairly educated) in order to have any real appreciation of the many morphological relationships which display vowel shift (the data from which the speaker would realize that there was an alternation). As Derwing and Baker note, "Chomsky's model incorporates at least one feature which is demonstrably counter to fact: it treats language acquisition as though it were an instantaneous process which takes place only at a time 'when all the data are in'" (1976, p.33). Unfortunately, by the time "all the data are in", the real speaker-hearer is both literate and educated and it is no longer safe to assume that his knowledge of vowel shift (if it can be demonstrated that he does have such knowledge) is a linguistic generalization which can be captured by a phonologically motivated rule, since it is by no means clear that his knowledge of the morphological pairs exhibiting vowel shift (from which he would then abstract the rule) was gained solely by exposure to the spoken language. However, the phenomena may be "captured", the real question for psycholinguists was whether this rule did in fact have any psychological reality for native speakers as this status was essentially attributed to the rule without any empirical evidence.

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This concern, then, led to extensive investigation which—was intended to resolve the psychological status of the "crucial" VS rule.

In the past decade or so a number of experimental approaches have been used to test the psychological validity of the VS rule. Basically, four different types of experiments have been conducted: Production tests, Preference tests, Recall tests and Concept Formation tests. These experimental studies and their results have been quite thoroughly summarized and reviewed in Wang (1985), and only some of the relevant studies will be mentioned here.

One particularly interesting study which provided some evidence for the influence of orthography in explaining the VS phenomena was that conducted by Jaeger (1979). The motivation for this experiment came out of a series of experiments testing for the psychological validity of some variation of the VS rule. In 1973 Moskowitz conducted a concept formation experiment from which she concluded that the spelling system of English was the probable source of children's knowledge of vowel shift alternations. Jaeger picked up on Moskowitz' conclusions and designed an experiment specifically "to see whether behaviour based on vowel shift rules could be differentiated from behaviour based on spelling rules" (1979, p.1). Adult subjects were trained to distinguish positive from negative instances of vowel shift alternations for pairs of words. Then they were given test cases to determine if they were responding on the basis of vowel-shift rules or spelling rules. The results of the experiment were interpreted to indicate that "the vowel alternations which native speakers feel belong together in a group are those which are designated by the spelling system of English" (p.15). As well, it appears that "speakers have abstracted out from orthography, or from the 'long-short' terminology, a set of five vowel alternations which they intuitively feel somehow go together, and this set of alternations can be tapped in the absence of any particular orthography or conscious consideration of the phenomenon" (p.15). The origin of this abstract "rule" then could quite possibly be the orthography of English.

With these and other studies as background, Wang (1985) conducted a series of additional experiments which were designed to investigate the nature of the productivity of the vowel alternation which theoretical linguists characterize by the VS rule. While a review of these studies is beyond the scope of this thesis, the point of interest is that virtually conclusive support was found for Jaeger's suggestion that the VS vowel alternation phenomenon has an orthographic source. Wang's results suggested that the VS phenomenon had its origin in the speaker's recognition that a vowel "letter" can be pronounced in different ways and Wang and Derwing (1986) argue that an orthographic explanation seems well suited to explain various aspects of the results. They conclude that "the orthographic explanation... is empirically superior to the phonological route of explanation represented by the VS Rule" (p.28). These studies, then, suggest that the phonological knowledge of native literate speakers may be substantially influenced by orthographic knowledge.

In addition to the research concerned with the VS phenomena, there is a significant body of relatively recent literature which also attests to the importance of the orthographic variable in phonological research. Some of this literature is theoretical or anecdotal, although a large body of experimental research exists as well. In the former category, Skousen (1982) developed a case for the centrality of orthography in phonological theory. He outlines three different ways that spelling can affect phonemic representation: (1) spelling pronunciation; (2) resolving the ambiguities due to phonemic overlap; and (3) influencing speakers' interpretations of general phonetic sequences. In the latter two categories he considers numerous examples (anecdotal or gleaned from specific studies) which clearly indicate that there are differences between literate adult and preliterate child perceptions about the phonological structure of words. He argues that "orthography is responsible for many of these differences" and that "as speakers learn to read, their phonemic representations are frequently altered to agree with orthographic representations" (p.28). As well, according to Skousen, orthographic considerations are, in fact, the sole basis of some phonemic analysis of speech proposed by linguists. For example, the preconsonantal nasal in words such as *bump* and *bank* has been regarded as a separate phoneme rather than a nasalized vowel. Decisions regarding the interpretation of an alveolar flap as either /t/ or /d/ have also been influenced by the orthography of the language. Skousen argues, then, that orthographic effects "have important consequences for phonological theory, since many linguistic arguments are based on adult perceptions of phonemic representation. Spelling plays such an important role in restructuring the phonemic representations of speakers that any discussion of the acquisition of phonology should take into account the effects of spelling" (p.37).

Although there are a number of other linguists who have addressed the question of orthographic influence, the "most extreme view", according to Ehri, is "proposed by the maverick linguist Householder (1971) who argues for the primacy of writing over speech" (1984, p.121). While this may be an "extreme" interpretation of Householder's work, he did argue that, on the basis of native speaker intuitions and from the standpoint of economy, underlying forms could be posited which were based solely on orthography. Householder's (mainly theoretical) treatise, however, appears to be largely a satire of typical transformational argumentation which often resorts to the simplicity metric as a basis for choosing the "best" grammatical account. Householder argues that, in terms of economy, it would be more efficient to posit the orthographic shapes as the lexical representations and to have a few spelling rules relate these underlying forms to their phonetic representations than to specify the phonological component which would require numerous rules to relate to the written forms.

While his economy argument forms the largest part of this particular essay, Householder also makes a number of points which raise interesting questions regarding the role of orthographic knowledge in linguistic accounts of the language. He notes that, in addition to the many outspoken proponents of the primacy of spoken language, "many linguists (e.g. Zellig Harris) imply, by their total silence, that writing and written materials (other than linguist's transcriptions, of course) are of no concern to the linguist, that his description of a language is complete if it correctly accounts for every possible spoken utterance" (p.250). Householder contrasts this position with the intuitions of literate native speakers which, he claims, views writing as primary and speech as a way of performing written materials. He claims that the naive mind holds the intuitive view that "we learn first to speak, and then to read and write, after which we must go back and correct all the errors we made by learning to speak first" (p.248). Householder suggests that a number of questions need to be addressed including "What is the relation of orthographic shape to phonological shape?" and "...does orthography influence pronunciation or does phonology influence spelling?" (p.251). The main contention of Householder's argumentation can be summarized in his opinion that "it is a queer division of responsibility that assigns everything recoverable from a text by reading it aloud to the grammarian's province, but excludes the form in which it is written" (p.251) and his conclusion that "there is no excuse for leaving orthography out of our grammars" (p.264).

Theoretical argumentation such as that adduced by Householder, however, is rare in the linguistic literature. As noted, orthography has been essentially a non-issue in linguistics since the "discovery" of "true" (spoken) language. The relatively recent emergence of orthography as a viable variable in psycholinguistic research was due more to linguistically oriented psychologists than to linguists per se. In contrast to many linguists, psychologists and reading specialists have devoted a great deal of research to the relationship between orthography and speech. Their focus has been quite different from that of the linguists, however. The main interest here has been the process of how children learn to read and their developing knowledge of structural units in speech. There are differing opinions about whether print shapes what develops in speech or merely reflects it. In this field, as well, many researchers have declared speech as primary — probably because children obviously acquire spoken forms first. This viewpoint, however, has sometimes led to overlooking the importance of orthography in the perception and anlysis of speech. Ehri (1984) notes that little formative power has been attributed to spellings and that "Assumptions about the primacy of speech have precluded recognition of the possible impact of print" (p.123). With regards to this issue and children's developing ability to read and spell, Ehri proposes that printed language is acquired as a representational system and that "spellings of words are retained in memory by functioning as symbols for sounds". A result of this is that "spellings may influence the way readers conceptualize the sound structure of words and possibly even the way they pronounce words under certain circumstances" (1984, p.129).

In order to determine whether knowledge of word spellings influenced children's conceptualizations of the sound structure of words, Ehri and Wilce (1980) conducted a series of experiments, the first of which found that there was a correlation between the number of letters used to spell a word and the number of speech sounds which children analyzed a word into. It was also found that children frequently discovered "extra" sounds in words whose spellings included letters for those sounds, as compared to words whose pronunciations were parallel but whose spellings lacked the extra letters. For example, many children detected four sounds in *pitch* and *badge* but only three sounds in the corresponding *rich* and *page*. The results of this study suggested that "it is when children acquire orthographic symbols that they become aware of additional phonemes in the pronunciations of words" (1980, p.376). In support of the results, children's comments indicated that their knowledge of spellings was influencing their segmentations. In spite of the fact that spellings were not visible during the task and the experimenter never mentioned spellings, some children remarked about their uncertainty as to whether you could really hear the 'b' in *comb*, the 't' in *pitch*, or the 'd' in *badge*. However, spellings were not the only basis for segmentations. Almost no children counted the silent 'e' (used to indicate the quality of a proceeding vowel) and consonant digraphs (such as 'ch' and 'sh') were generally understood to represent only single sounds. These results indicated that spellings were interacting with pronunciations to determine how the sound structure of words was conceptualized. The simple presence of letters in spellings does not dictate the sound structure but the critical factor was identified as being the "sound-symbolizing function" of the letters.

Ehri and Wilce's second experiment utilized nonsense words in order to investigate whether the way readers conceptualize sound structure is dependent upon the sounds they see symbolized in the words' spellings. Five nonsense pairs which were identical in pronunciation were constructed. These were: *banyu-banu; drowl-drol; simpty-simty; tadge-taj; zitch-zich.* Half of the subjects practised reading the pseudo-word spellings with extra letters, the other half saw control spellings. This was followed by a phonetic segmentation task and a spelling task. The results showed that the subjects who learned the extra letter spellings were invariably the ones who found the sounds symbolized by the extra letter. These findings indicated that "the visual forms of words acquired from reading experiences serve to shape learners' conceptualizations of the phoneme segments in those words" (1980, p.379).

A number of other researchers have also provided data which indicates that children's experience with alphabetic orthography influences their conceptualization of the sound structure of words. Studies of preschoolers' invented spellings reveal ways in which naive spellers' phonetic perceptions change as they gain experience with print. Beers and Henderson (1977), Read (1971, 1973, 1975) and Barton, Miller and Macken (1980) conducted studies which showed that children may classify sounds quite differently from literate adults until they have some knowledge about standard letter-sound relations and spelling conventions. For example, the affrication at the beginnings of words such as *train* and *chair* may be treated as the same single sound /č/. Children with some reading ability tend to analyze 'tr' as two sounds rather than one — with the initial sound being more like that in *teddy* than in *chair*. Very likely, it is familiarity with orthographic conventions that shapes the later perceptions of these words.

Some of these interesting analyses of prereaders and beginning readers' invented spellings have been noted by Ehri (1984). She also compared the spellings of more or less mature beginning readers. These data provide interesting insights into the phonetic perceptions of naive spellers and indicate that their analyses change as a result of experience with print. One of the main findings is that novice spellings do not represent as many phonetic segments as those produced by mature spellers. It appears that, although children have a knowledge of letter-sound relations, their lack of experience with conventional print hinders them from dividing the sound stream "appropriately". When the pronunciation is perceived to contain a consonant letter name, the letter may be written to represent a vowel as well as the consonant (i.e., 'YL' for *while*). Once children learn to attend to phonetic units rather than blends or syllabic units, these letter-name errors tend to disappear.

Consonants, as well as vowels, are sometimes omitted in the spellings of prereaders. One which often does not appear is the preconsonantal nasal (i.e., the occurrence of /m/ or /n/ between a vowel and a consonant). For example, a child may spell *thek* for *think*, or *bope* for *bumpy*. According to Ehri, this omission occurs because the nasal lacks its own place of articulation and so combines with the vowel to form a single phonetic segment (a nasalized vowel). This is regarded as "an instance where conventional orthography actually misleads the reader into believing that the vowel and consonant are two separate sounds, even though they are one sound phonetically" (1984, p.113). In order to verify this hypothesis, Ehri carried out a study which compared the phonetic segmentations and spellings of first graders and fourth graders on words which contained preconsonantal nasals. The results confirmed that there was a difference in the conceptualizations of the sound structure of such words. Novices ignored the nasal while the more experienced spellers regarded it as a separate sound.

Another well documented case where experienced spellers differ from novices is the classification of alveolar flap sounds. Ehri and Wilce conducted two experiments to determine whether children's perception of flap sounds in real words was influenced by experiences with print. According to the expectations of the experiments, spellings should influence the perception of intervocalic alveolar flaps which lie between two vowels in stressed syllables (e.g., *middle, little*). Although the flap phone is acoustically closer to [d], it is sometimes spelled 't' and other times 'd'. Initially, children unfamiliar with spellings would be expected to analyze flaps as /d/ based on acoustic criteria. Once they have had some experience with print, they would experience conventional 't' as well as 'd' spellings of words with flaps and may shift to 't' in their spellings. Finally, as their memory of specific spellings grows, their choice of what sound is really "there" could be determined by the spellings of the words.

In the first study, first, second, and fourth graders listened to 30 familiar words containing flaps on tape. In some of these words, flaps were present in the root forms; in others, they were created by adding inflections (i.e., *writing* and *maddest*). Words were presented in a context which depicted their meanings (i.e., "I wrote a *letter* to my Grandma") and then alone. Care was taken to ensure that the pronunciation was a flap rather than a clear /d/ or /t/. Subjects listened, repeated and then made a judgement by naming the letter 't' or 'd'. It was expected that older subjects' sound judgements would reflect more spellings than the younger ones. Unfamiliar spellings were expected to be judged acoustically as /d/ with the result that the accuracy would be greater for 'd'-spelled flaps. These expectations were confirmed in the results, as the data indicated that children's judgements of flap sounds become more like the sounds represented in spellings as they got older. The interpretation of these results was that familiarity with spellings shapes metalinguistic beliefs about sounds.

A second experiment was conducted to correct several weaknesses in the first and to show more directly that subjects' perception of flap sounds was influenced by learning spellings. In this study, knowledge of spellings was manipulated as an independent variable in order to insure that subjects analyzed sounds rather than letters when they made their judgements. The experimental group saw and pronounced a set of words containing medial flaps spelled with 'd' and 't' while subjects in the control group heard and pronounced the words but never saw spellings. Then both groups were given a rhyme-judgement task to see whether the subjects in the experimental group judged rhymes according to spellings more often than the control group. In order to minimize the influence of letters on the subjects' sound judgements, the rhyme task was conducted with pictures. The procedure which was used had the effect of forcing subjects to resolve the flap as either a final voiceless /t/ or a voiced /d/. The results of the study confirmed predictions that even though the task was strictly oral and there was no mention of letters or spellings, the effect of the spellings on pronunciations was evident. The results of this experiment led Ehri and Wilce to conclude that learners' conceptualization of ambiguous sounds is influenced by their knowledge of the spellings of the words.

From the research already noted and from a number of equally interesting studies which will not be mentioned here, it becomes apparent that the orthographical influence in research simply cannot be overlooked or lightly dismissed. While there has been a fair amount of work done concerning phoneme-grapheme correspondences, most of this research was conducted in the interests of reading or spelling instruction rather than for the purpose of resolving linguistic questions. The existing literature on the subject is characterized by a certain amount of disagreement and uncertainty as to whether orthography is a distorting influence on phonological intuitions or whether orthography should be viewed as a reflection of phonology. While it may not be appropriate to take an either/or stance on one of these positions, it is nevertheless important to determine the extent and the direction of the influence of orthography, particularly in linguistic experimentation. This question of orthographic influence is particularly important for investigators of the sound systems of language since, if orthography is influencing native speaker's intuitions, the extent of this influence should be determined and controls should be built into the experiments. As Derwing and Nearey have suggested, the use of pre-/non-literate subjects in replications of phonological experiments would be a control for orthographic interference. However, as they have also noted, it would be very difficult to find (and probably also to use) such adult subjects and the use of children tends to confound the question even more. For these reasons, it is important that research be devoted to the "orthographic variable" as a specific object of study.

With regard to orthographic interference on phonological judgements in experimental research, two related questions have been raised. The first concerns the possibility that the extent of orthographic interference may not be a "problem" in some tasks, whereas others may "tap" subjects' knowledge of orthography. The other question concerns the effect of presentation mode (i.e., visual or oral) in experimental tasks and the possibility that it can be used as a control for orthographic interference. Dow's (1981) study was designed to focus on these questions and to clarify some suggested answers which arose from Derwing and Nearey's research.

In order to address the questions and to determine the extent of orthographic interference, two tasks were selected for Dow's study. The first (Experiment 1) was a rhyme task. Given task items, subjects were required to access their phonological knowledge in order to supply rhyming words. The rhymes they provided were expected to provide information about orthographic influences on that knowledge. The second task (Experiment 2) was a "segment count" task. That is, subjects were asked to identify the number of "speech sounds" in a given set of words. In both tasks, presentation mode was included as a variable. In each case, the stimulus words were presented orally to ensure that the intended pronunciation was perceived by all subjects. Half the subjects in each group were presented with the words visually as well. This design then tested the effect of both type of task and presentation mode.

The results of Dow's (1981) study yielded clear evidence that, depending on the type of task, orthography can be a very important influence on phonological judgements. While presentation mode did not make any significant difference in the speech sounds task, it had a significant effect in the rhyme task. This suggests that "knowledge of orthography is differentially utilized, dependent on the type of task, and therefore could potentiate or interfere with phonological judgements depending on how much phonographemic divergence there is" (p. 84). While this study did not address the question of individual differences, it is possible that (as Ehri suggests) "individuals differ in their susceptibility to the effects of print... [and] in how they process printed language". This raises the possibility that "print has a greater impact upon some readers than upon others, depending upon the way they process print... [and that] good spellers may be most susceptible to the phonological effects of print" (1984, p.147).

In addition to the mounting evidence which shows orthography to be a significant experimental variable in phonological research, there is a body of literature which raises questions concerning the fundamental construct of most phonological analyses; namely, the psychological reality of the phoneme as a perceptual unit. The main question raised here is whether the phoneme is a "natural" unit of speech segmentation for speakers or whether the perception of the phoneme as a unit is largely an artifact of being exposed to an alphabetic system of writing. In spite of the central role which phonemes have played in theoretical descriptions of language, there is considerable support for the latter position. Evidence for this is largely gleaned from studies with preliterates and illiterates where the results point to phonemic segmentation as a learned skill. One such study is that conducted by Morais, Cary, Alegria, and Bertelson (1979). These researchers administered two tasks which required subjects to manipulate phones to Portuguese literate and illiterate adults who were controlled for socio-economic background, childhood history, and employment. Subjects were all of peasant origin and were working in the textile industry at the time. The literate subjects had all learned to read and write at age 15 or older by attending government sponsored literacy classes. The tasks required that the subjects either delete the first phone from an utterance provided by the experimenter or to introduce an additional phone at the beginning of the utterance. There were clear differences in the way in which the groups performed. Whereas the literates performed the tasks easily, the illiterate adults could neither add nor delete a phone at the beginning of a stimulus item. These results were taken to indicate that "awareness of speech as a sequence of phones is... not attained spontaneously in the course of general cognitive growth, but demands some specific training, which, for most persons, is probably provided by learning to read in the alphabetic system" (p.323).

The conclusions of the Morais et al. (1979) study are supported by a good deal of additional literature reporting studies which attest to the importance of orthographic knowledge in influencing or shaping phonological knowledge. Dow (Ph.D. dissertation in progress) is concerned with the perceptual reality of a variety of proposed phonological units. Her work reviews a good deal of literature (not mentioned here) which is concerned with the interrelationship of phonology and orthography. While further review of these studies is beyond the scope of this thesis, the conclusion implied by the available literature is inescapable: the "psychologically real" phonological knowledge of native literate speakers may be significantly affected by their orthographic knowledge. Outside the area of phonology, however, there is very little literature concerning the influence of the "orthographic variable" on linguistic judgements. The existing literature which relates to the area of morphology will be discussed in the section concerned with derivational morphology (Section 2.4.2).

2.3 ENGLISH ORTHOGRAPHY

2.3.1 INTRODUCTORY REMARKS

This section is devoted to identifying and reviewing some of the literature concerned with the nature of the English orthographic system and the types of knowledge and processes language learners may gain or employ when dealing with this system of writing. This is obviously a very vast topic to which volumes have been devoted and no more than a glimpse into this field of study can be afforded here. It is, however, important to review some of this literature, since this thesis is concerned with spelling productions as well as the methodology for probing native speakers awareness of morphological relationships. A few crucial questions, then, must be addressed. These include the following: (1) Is there any reason to suspect that there may be some relationship between a native speaker's spelling productions and his ability to identify morphemes in "derived words"? (2) Is there anything about the English orthographic system which may be used to enhance this awareness and, if so, do speakers make use of this "information"? (3) What "degree" of a relationship could reasonably be expected and on what basis? These questions cannot begin to be addressed without some familiarity with the literature on English orthography and the insights which can be gleaned from existing research.

Generally speaking, two large bodies of literature which are relevant to the topic of English orthography can be identified. The first is largely theoretical and can be associated with linguists who have been concerned with the nature of the English orthographic system.

The second is essentially research orientated and is more closely associated with educators and cognitive psychologists who are interested in the process of reading (and, more recently, the processes involved in learning to spell). Although there is presently a move towards integration of insights and methods in empirical work, the distinction between the linguistic viewpoints and those of psychologists and educators is readily apparent in the literature. The (relatively new) field of psycholinguistics, however, is well on the way to integrating the linguistic and psychological approaches. This is apparent in the work of Henderson (1982), who observes the distinction between the two realms and notes that "although it is true that no amount of contemplation of the nature of the correspondences between script and sound or script and meaning can provide the answer to psychological questions about what strategies we actually follow when we read or spell, such psychological issues cannot be clearly formulated in a linguistic vacuum" (p.64). He emphasizes that "it is important to be clear about precisely what it is that we are asserting when we claim that the subject is capitalizing upon some form of regularity" (p.64) and notes that "the demonstration of the existence of a form of regularity in no way entails that it is used, or even can be used, by the reader or speller" (p.65). When investigating how a speaker will deal with English orthography (learning to read and spell), Henderson suggests that it is important to examine in some detail "what the language allows and encourages" before taking up a psychological position. In his words, "The linguistic evidence does not provide the psychological answers, but it goes a long way toward clarifying the questions" (p.65).

With respect to the psycholinguistic perspective as verbalized by Henderson, this review of literature on English orthography is organized as follows: the first two sections are essentially concerned with linguistic viewpoints. The major consideration here is the nature of the English orthographic system and various linguistic positions are reviewed. While English orthography can be viewed as a system with some vague sense of design, it would seem naive to expect an understanding of the "system" without at least a minimal appreciation of the historical processes which have shaped the written language. A first section, therefore, makes reference to some of these historical points. The final two sections deal somewhat more directly with the concerns of this thesis. English spelling is considered with respect to its correspondences to sound and representation of morphemic units. Some empirical studies are reviewed which give insights into the psychological appropriateness of various linguistic descriptions and some strategies which language learners may adopt when faced with the complexities of the English orthographic system.

2.3.2 NOTES ON THE HISTORY OF ENGLISH SPELLING

> In a vast conspiracy, history has mined the child's road to literacy with hundreds of exceptions and minor rules.
>
> (J. Feldman, 1978)

In his presentation of the history and evolution of writing, Gelb (1952) identifies three main techniques for coding language in writing: (1) logographs, with written symbols representing linguistic units of meaning, (2) syllabic writing, with symbols representing whole syllables of speech sound, (3) alphabetic writing, with symbols representing individual phonemic units of speech sound. With respect to alphabetic systems, Gelb (1974) notes that the relationship between speech and writing "is generally stronger in the earlier stages of a certain system of writing and weaker in its later stage. This is due to the fact that a writing system when first introduced generally reproduces rather faithfully the underlying phonemic structure. In the course of time, writing, more conservative than language, generally does not keep up with the continuous changes of language and, as time progresses, diverges more and more from its linguistic counterpart" (pp. 297-298).

English orthography is obviously of the alphabetic type. The correspondences between the phonemes of the language and the symbols (graphemes, which may involve one or more letters) used to represent the phonemes, however, are not always straightforward or "obvious". As well, English orthography preserves morphemic and syntactic information which frequently does not follow the "phonemic" code. This observation has led some linguists to the view that the basic unit of the code of the English writing system is not, as is commonly supposed, the phoneme (see Section 2.3.3). However, as Downing and Leong (1982) note, "the unit which seems to have been recognized throughout the history of English orthography (though not so named until comparatively recently) is the phoneme" (p. 55).

Assuming that English orthography was originally intended to be a graphic code for phonemes (or a visual code for representing distinctive speech sounds), it may prove instructive to make an excursion into history in order to understand some of the complexities of the present system. This is important in order to get a perspective on the various attempts to characterize the nature of the present orthographic system (Section 2.3.3). Although the present-day language learner can not be expected to have any understanding of the historical motivations that shaped the current writing conventions, the nature of the system he is confronted with may influence the types of strategies he employs and the sorts of generalizations he can be expected to glean in the process of mastering the written language. As Henderson (1982) notes, "Historical analysis often allows us to distinguish between those irregularities of the spelling-sound correspondence that are arbitrary, usually owing to faulty analogy or mistaken etymology, and those that are motivated by some linguistic principle" (p.66). Presumably, those so "motivated" will be much more amenable to the learning processes of rule extraction and generalization. Those aspects of the writing system which are (or which appear to be) arbitrary and unmotivated may require significantly different strategies in order to be mastered by the average reader and speller.

English orthography has been subjected to and shaped by a wide variety of historical influences. While a number of sources on the history of English spelling are available, the comprehensive and scholarly investigation provided by Scragg (1974) is widely quoted and appears to have become the classic of our day. The few historical points which are noted here are gleaned either from Scragg's work or from authors who relied heavily on this excellent monograph. No attempt is made here to summarize this very detailed work; the only point of the remainder of this section is to note a few influences which have contributed to the present-day nature of the writing system of English. More comprehensive distillations of

Scragg's work can be found in Henderson (1982) and Downing and Leong (1982). Venezky (1976) also refers to Scragg's work in discussing the influences which have shaped Modern English spelling.

The English writing system utilizes the Roman alphabet which descended from the original Greek system. The Roman alphabet was introduced into England around 600 A.D. when Roman and Irish missionaries converted the Anglo-Saxons to Christianity. Prior to this time, it is probable that the Anglo-Saxons used the runic alphabet which they brought with them from Germany when they invaded England. The most important Runic influence was the adoption of the symbol called *thorn* which was used to represent the initial consonants in the words *thigh* and *thy* (sounds which corresponded to a single phoneme in Old English). Eventually, the Runic thorn succumbed to the Roman transliteration 'TH' and two letters became a single functional segment (sometimes referred to as a "grapheme" or a "digraph").

According to Scragg, the best records of Old English can be attributed to the West Saxon scribal tradition. Of this period of standardization, Scragg states that, "As a whole, Old English spelling as developed in the West Saxon tradition was much nearer a one-to-one relationship with sounds than is its Modern English descendent" (p.11). However, as Henderson (1982) summarizes, "The price of the stability of spelling in Old English was an inevitable lack of responsiveness to changing pronunciation" (p.67). The orthography did not keep pace with the changes in speech and phonological drift (particularly towards the end of the Old English period) considerably weakened the orthographic correspondences. As a result of the conservatism of this period, "the orthography came to consist of coexisting layers of fossils from each wave of innovation. These innovations had diverse sources, of which perhaps the most notable was the Norman conquest" (Henderson, 1982, p.67).

As a consequence of the Norman invasion, the scribal tradition in English declined and a pervasive standard was lost. The early period of Middle English spelling was characterized by instability and Anglo-Norman borrowings. From this period of time to Modern English, a wide range of influences have left their mark on the English spelling system. Downing and Leong (1982) attempt to convert Scragg's chronological survey into an analysis of the motives and forces which have caused the English writing system to be what it is today. They organize their review of these "forces" into two categories — "motivation for stability" and "motivation for change". A few points from their discussion are reviewed here without regard for chronological accuracy.

Throughout the history of the English writing system there have been deliberate attempts to stabilize the orthography. As noted, the early period of the West Saxon standardization was relatively stable. Following the long period of neglect caused by the introduction of French by the Normans, renewed motivation for standardization came with the revival of English in the chancery. Beginning around 1430, the dialect of the London area was used to establish a "standard" for the language. Contrary to popular supposition, however, Caxton's first English printing press (1476) was not a great stabalizing force. According to Scragg, the first printers lacked the discipline and professionalism of the scribes before them and, in fact, encouraged a lack of conformity in spelling. Moreover, many of the type setters were foreigners, since the main qualification for the job was previous experience with the printing press. The printers' inconsistent spellings were not even based on a standard dialect, let alone a systematic alphabetic principle which would determine "regular" spellings. Words were lengthened at will to fill up a line or consonants doubled for decorative effect.

The schoolmasters of the Middle English period initiated a driving force for standardizing English orthography. The most important of these was probably Richard Mulcaster's treatise of 1582, in which he purposed to increase standardization by drastically reducing the number of acceptable alternatives. Mulcaster's principles of selection, however, were not necessarily phonemically based. He was influenced by analogy with other written words and also supported cases of etymologically based spelling.

Mulcaster's work led to two other major channels of stabilization. One of these was the schoolmaster, Edmond Coote, who turned Mulcaster's theory into classroom practice. His workbook for the teaching of reading and writing was published in 1596 and attained great popularity. The second channel for Mulcaster's work was through the printers. Scragg recognizes the power of the press and concludes that the spelling book and the primitive dictionary, with their growing authority during the sevententh century, induced the printers to adopt a common orthography.

In spite of the stabilizing forces noted here, the motivation for change in the spelling system has sometimes been stronger than the desire for stability. Some of these motivations for change were indirect results of historical events. One result of the Norman conquest, for example, was that a "large proportion of present-day English vocabulary is derived from French. A dictionary count might put it as high as forty per cent, though the number of French borrowings in the average English sentence is much smaller because most of the basic and commonest words are..... inherited from Old English"(Scragg, p.40). According to Scragg,

> ... by the end of the twelfth century, cultured Englishmen were not only bilingual but also biliterate; many words of the vast influx from French into English were already familiar to Englishmen not only in French as a spoken language but in French writings too. What was required of such words in English writings was not an anglicised spelling (which might serve to remind readers of the pronunciation) but the spelling by which they were traditionally represented in French, however ill that accorded with English conventions (p.42).

In addition to this effect on the vocabulary, many errors crept into the writing system during this period due to the effect of scribes who were often French speaking and had little training in English conventional spelling. As well, Latin provided another "set of spelling conventions to cause additional confusion to a situation already very fluid" (p.43). Scragg cites numerous examples of "the results of scribes' confusion between English, French and Latin spelling" (p.44), including the changing of 'u' to 'o' in many English words such as *come, some, monk, son, tongue, wonder, honey, worry, dove, love.*

Another very influential motivation for change was the Renaissance, during which a vast number of English words were "etymologized". The great admiration for classical culture and language motivated the coining of new words derived from Greek and Latin as well as the restructuring of many existing orthographic forms. Many of these etymological changes were erroneously motivated since, as Scragg notes, "The zeal of those intent on reforming spelling along etymological lines often led them astray in cases in which their knowledge of Latin exceeded that of the history of the words they were emending" (p.57). A great deal of these "etymological" orthographic changes remain in the modern spelling system.

According to Henderson (1982) (who was summarizing Scragg's work),

> The impact of the etymologizing movement was to shift the correspondence of spelling toward 'meaning' as represented by morphology, at the expense of sound.... But this principle nevertheless admits many realizations which are entirely arbitrary. A major source of error in application of the principle involved mistaken etymology... Another source of arbitrariness in the orthography, acting as a sort of extension of mistaken etymologizing, was the mistaken analogy. Thus OE coude became could, with a silent 'L', by analogy with would (OE wolde) (p.68).

In addition to these major influences on the English orthographic system, a number of less extensive, pragmatically motivated influences can be identified. These include spellings adopted to avoid homograph/homophone coincidence, considerations of visual aesthetics, forms motivated by their convenience for spacing on the printing press and economic factors, including the tendency to elongate spellings when clerks were paid for writing by the inch.

As a result of these, and many factors not discussed here, the English orthographic system became something quite removed from its original ancestor. Scragg portrays English orthography as a system "considerably influenced by the conventions of foreign systems", although "the native tradition was never entirely lost". As a consequence, "our spelling is thus the result of the overlaying, for nearly a thousand years, of one tradition upon another", the product of a "sequence of events which has caused us to erect such a curious and at times eccentric building on so simple and sound a ground-plan" (p.14).

2.3.3 THE NATURE OF THE MODERN ENGLISH ORTHOGRAPHIC SYSTEM

> [E]veryone... has to admit that of all languages of culture English has the most antiquated, inconsistent, and illogical spelling.
> (R. E. Zachrisson, 1930:10, quoted in Venezky, 1970)

> There is... nothing particularly surprising about the fact that conventional orthography is... a near optimal system for the lexical representation of English words.
> (Chomsky and Halle, 1968)

> [A]s a piece of apology for present-day English spelling, the argumentation adduced by Chomsky and Halle is hardly convincing.
> (Vachek, 1973)

English orthography is often considered to be a highly inefficient system (for mapping graphic symbols to phonemes) which is marked by an inordinate degree of inconsistent and arbitrary conventions. It is, however, a "system" of some sort and, in the past several decades, a number of linguists have attempted to characterize the nature of this system. Some of this literature suggests that there is a considerable degree of regularity and structural consistency which emerges on a level somewhat more abstract than the strict sound-symbol correspondences. This section identifies some of the varying linguistic views on the nature of the modern English orthographic system and outlines a few major characteristics of each description. A more complete review of these linguistic analyses of the writing system can be found in Downing and Leong (1982), from which many of the points here are taken.

The classical view of the English writing system is that the basic orthographic units (graphemes) are symbols for phonemes and that much of the original regularity has been lost due to changes in pronunciation. More recently, however, a number of linguists have begun to question whether the orthography (either as a whole or in part) is a code for phonemes or whether there may be systematic regularities which are observable at different levels of representation. According to Downing and Leong (1982), an examination of the linguistic literature reveals three broad schools of thought on this issue: classical phonemic descriptions, structural descriptions, and multi-code descriptions.

2.3.3.1 CLASSICAL PHONEMIC DESCRIPTIONS

Leonard Bloomfield (1942) held the traditional taxonomic view of English orthography as a system of phoneme-grapheme correspondences. He was interested in the child's task in learning to read and suggested that the primary skill needed here was the ability to associate speech sounds with the letters of the alphabet. He emphasized that the phonemes which related to letters do not occur in isolation in natural speech but was nevertheless quite certain that "alphabetic writing... directs the reader to produce certain speech-sounds" (p.129).

Charles Fries (1963) was another linguist who described alphabetic writing as being basically phonemic. He expressed the view that "an alphabet is a set of graphic shapes that can represent the separate vowel and consonant phonemes of the language" (1963, p.156). The essential unit coded in an alphabetic system, then, is the classical linguistic concept of the "phoneme".

Neither Bloomfield or Fries, however, claimed that English orthography could be completely explained in these terms. They accepted that the system was not a perfect one-to-one code of grapheme-phoneme correspondences, but saw the divergences from the phonemic principle as being a result of the vicissitudes of history.

Fries did not hesitate to claim psychological reality for his analysis. In his view, it not only explained why people spelled the way they do (he had subjects spell nonsense syllables), but was also the key to the teaching of reading. Like Bloomfield before him, he made specific pedagogical proposals which, incidentally, have not found a high degree of popularity in the schools. Both Fries and Bloomfield, then, described English orthography as a writing system with a basic principle of regular relationships between graphemes and phonemes, but with imperfections in the regularity of the correspondences.

2.3.3.2 STRUCTURAL DESCRIPTIONS

The basic principle of the structural descriptions of contemporary English orthography is that the writing system actually exhibits a great deal more regularity than is commonly assumed, albeit on a more abstract level than that of phoneme-grapheme correspondences. These descriptions are fairly complex, even technical, and justice cannot be afforded them here. What follows is a taste of the original, particularly as reflected in various reactions to these works.

In their monumental book, The Sound Pattern of English (1968), Chomsky and Halle made the celebrated claim that there was "nothing particularly surprising about the fact that conventional orthography is... a near optimal system for the lexical representation of English words" (p.49). This evidently came as quite a "surprise" to a number of linguists, psychologists and educators alike since the literature in each of these fields is replete with reactions against this notion.

Chomsky and Halle endowed their abstract lexical representations with psychological reality and, as well, claimed that "It is a widely confirmed empirical fact that underlying representations are fairly resistant to historical change" (p.49). On the status of the phoneme in orthography, Chomsky (1970, p.15) states that "there is little reason to expect that phoneme-grapheme correspondence will be of much interest because it appears that phonemes are artificial units having no linguistic status". Furthermore, "the rules of sound-letter correspondence need hardly be taught..., nor is there any particular reason why the teacher should be aware of these processes or their detailed properties. These rules, it appears, are part of the unconscious linguistic equipment of the nonliterate speaker" (Chomsky, 1970,pp.15-16). This view on reading appears to be a reformulation of the often quoted SPE statements.

> Orthography is a system designed for readers who know the language, who understand sentences and therefore know the surface structure of sentences. Such readers can produce the correct phonetic forms, given the orthographic representation and the surface structure, by means of the rules that they employ in producing and interpreting speech.
>
> (Chomsky and Halle, 1968, p.49)

A major contention of Chomsky and Halle's work seems to be that the orthography of English is related to psychologically real abstract lexical representations rather than to traditional phonemes. In describing the process of reading aloud, Chomsky and Halle claim that "reading will be facilitated to the extent that the orthography... corresponds to the underlying representations provided by the grammar... To the extent that these correspond, the reader can rely on the familiar phonological processes to relate the visual input... to an acoustic signal. Thus one would expect that conventional orthography should, by and large, be superior to phonemic transcription, which is in general quite remote from underlying lexical or phonological representation and not related to it by any linguistically significant set of rules" (pp.49-50).

These assertions have not gone unchallenged and, particularly, the statement on the "near-optimal" nature of English orthography (for representing untestable lexical representations) seems to be generally regarded with skepticism. Francis (1970), for example, analyzes Chomsky's claim into three parts: "(1) that the prephonetic level of surface structure, the level of lexical representation is linguistically meaningful; (2) that this level and the lexical representations that it includes are psychologically real, though below the level of conscious knowledge; and (3) that the standard orthography is, with minor exceptions, isomorphic with that level" (p.48). Francis then takes up each of these claims separately and poses a few "commonsense objections" to each one. For example, one of Francis' objections to the psychological reality of such lexical representations is that "the assumption that all speakers store the same lexical items in the same way seems to run counter to the great individual diversity that obtains in other forms of memory. The way in which particular parts of other systems are stored may be highly idiosyncratic, probably as a result of the way in which they were learned" (pp. 49-50).

Francis also suggests that, if the lexical representations did have psychological reality, there should be some way of getting at them "by some other route than the highly ingenious analysis that Chomsky and Halle have used and that has taken them a good many years to work out" (p.50). At the very least, one should sense some intuitive recognition when confronted with them rather than the common reaction of "extreme skepticism". With respect to Chomsky's third claim (that the orthography is virtually isomorphic with the level of lexical representation), Francis states that "in the light of the facts about the history of English... it would be indeed remarkable if his claims were true" (p.51). Downing and Leong (1982) capitalize on this objection when they state:

> In view of the vicissitudes on the course of the long history of English orthography... it is difficult to accept Chomsky's claim for the "near-optimal" quality of the written form of English. Psychoanalysis might even extend the unconscious element in Chomsky's theory to evoke motivational mechanisms which guided careless scribes and ignorant printers' apprentices to make "near-optimal" errors rather in the manner of Freud's (1920) unconscious motivation for slips of the pen in The Psychopathology of Everyday Life (p.71).

Another superficially naive but revealing question has occasionally been posed in response to the SPE assertions on the nature of English orthography, namely the following: If the orthography is so optimal, and if the abstract lexical level is so accessible, why would people have so much trouble with English spelling? (cf. Henderson, 1982, p.97; Downing and Leong, 1982). Henderson (1982) even claims that his "spelling has improved since gaining access to the description of [his] abstract lexical entries in the pages of The Sound Pattern of English" (p.97).

Along with the theoretical and "commonsense" objections to the SPE claims, there have been considerable experimental attempts to test the claims of the theory. The results have generally proved negative and there is virtually no empirical support for the psychological reality of the SPE analysis. A review of relevant experimental literature is beyond the scope of this thesis but references to relevant research can be found in the reviews by Downing and Leong (1982, pp.70-76) and Taylor and Taylor (1983, pp.103-107). The latter pair of researchers conclude along with Trammell (1978), that "although the orthography may be 'near-optimal' for a formal system of rules, the speaker-reader's internalized rules are not nearly so well defined or consistently applied as those of SPE" (p.107).

A second "structural" description of the nature of English orthography which Downing and Leong identify is the work of Richard Venezky (1970). In his book, The Structure of English Orthography, Venezky states that "English spelling is more complex and contains a higher degree of patterning than was ever assumed before" (p.10). The stated function of his work is "to show the patterning which exists in the present orthography — not just in terms of regular spelling-to-sound rules, but in terms of the more general phonemic and morphemic elements which characterize the system" (p.11). According to his view, "Whatever may have been the relationship between writing and sound, when the first Old English writings were inscribed..., and whatever may have been the reasons for the subsequent development of this system..., the simple fact is that the present orthography is not merely a letter-to-sound system riddled with imperfections, but instead, a more complex and more regular relationship wherein phoneme and morpheme share leading roles" (p.11).

Venezky's work is generally considered one of the most detailed examinations of English orthography from the viewpoint of grapheme-to-phoneme translation. It must be noted here, however, that Venezky's analysis is one-way with correspondence rules stated in the direction of spelling to sound (how graphemes are pronounced rather than how speech sounds are written). This is important to note since, as Haas (1970) has clearly demonstrated, there is asymmetry between the grapheme-to-phoneme and phoneme-to-grapheme relationships (with the grapheme-to-phoneme correspondences being considerably less ambiguous). That is, as Henderson (1982) notes, "what is predictable in the reading direction, need not be so in the spelling direction, and the converse is also true" (p.72). This thesis is more concerned with the phoneme-to-grapheme relationships; nevertheless, it is worth taking at least a cursory look at Venezky's view of the nature of the English orthographic system and some reactions to it.

Venezky appears to attack the notion of the phoneme per se as the basic unit coded in the orthography. In relating the written language to the spoken language, he posited an internal structure. In his view, the written symbols code units of language which are "morphophonemic" and the actual phonemes are derived from these units. In an extensive analysis of the orthography, Venezky computer-tabulated and analyzed the spelling-to-sound correspondences in the 20,000 commonest English words with the intent to "discover and describe the underlying patterns of the current orthography" (p.126). While the details of this rather ambitious analysis cannot be considered here, the following quotation captures the general idea of the overall working of Venezky's system:

> In the spelling-to-sound model employed here, graphemic words are divided into their graphemic allomorphs, and then these allomorphs are related to intermediate (morphophonemic) units by an ordered set of rules. Other rules then relate the morphophonemic units to phonemic forms. All rules which are based upon nongraphemic features are applied in an ordered sequence on the morphophonemic level, yielding various sublevels of intermediate froms for each word. The final morphophonemic form is then mapped automatically onto the phonemic level (p.46).

This analysis of the present-day form of English orthography has received mixed reactions. Downing and Leong call Venezky's description "ingenious" and "probably the most thorough scholarly description at present available". However, they object to hints that the analysis might be related to the psychological reality of the processes of learning to read and also suggest that his claims for the predictability of the underlying patterns are "exaggerated", as they are sometimes based on rules employed for arbitrary purposes. Downing and Leong note that Venezky has (in another publication, 1970) "argued very effectively that regularity is in the eye of the beholder". They suggest that his argument should be applied to his own anlysis since "he cannot escape from his own conclusion by relabelling regular and irregular as predictable and unpredictable, as he claims (Venezky, 1970, p.42). People make predictions on the basis of perceived regularities. In other words, Venezky's analysis is merely one possible way of describing present-day English orthography. It does not necessarily have psychological reality in the way in which readers past or present have perceived English writing and reacted to it" (p.79).

Henderson (1982, pp.72-74) also refers to Venezky's work and has similar objections to his analysis of current English orthography. Among other criticisms, he states that Venezky's taxomomy derives from an "arbitrary mixture of linguistic and pedagogic criteria" (p.74). In an attempt to clarify the issue, Henderson considers the linguistic criteria bearing upon predictability and states that "there are three types of source for predictive rules: morphology, phonemic context, and graphemic context". He gives examples of these and argues that the concept of a "rule" is not clearly defined, since these fairly powerful rules "shade off gradually into predictabilities of other sorts". Most spelling-sound mappings have an explanation of some sort and there are a whole range of historical explanations. "Such explanations come in varying shades of rule-likeness. At one extreme there are explanations that appeal to historical accidents... At a slightly greater level of generality, there are foreign borrowings... There are, therefore, various sorts of linguistic justifications for particular spelling-sound correspondences. It is quite another matter to decide which of these justifications can usefully be employed in teaching the child to read. We cannot determine a priori what rationale will be memorable to the child, and many of the more powerful linguistic rules depend upon subtle and complex variables that may be inaccessible to the child" (p.74).

2.3.3.3 MULTI-CODE DESCRIPTIONS

Downing and Leong (1982) identify three linguists whom they consider to have supplied "multi-code" descriptions of English orthography: Lefevre (1964), Albrow (1972) and Vachek (1973). The basic proposal of these descriptions is that "English orthography primarily represents phonemes, but that it has other overlapping codes in addition" (p.79). Presumably (as the historical evidence suggests), the initial system was a code for phonemes; later developments, however, created additional codes for other aspects of language. Only a few points from Vachek's theory will be considered here. Much of this is summarized from what Downing and Leong have identified as the main points of this work.

According to Vachek's "functionalist" theory of written language, the spoken and written norms of the language have an independent existence, despite their obvious connections. This is ~~because each system~~ has its own "functional" motivation. Vachek agrees that the basis of the relationship between the norms (in alphabetic systems) is some degree of grapheme-phoneme correspondence. However, "alongside this basic type of correspondence one can also ascertain in these norms at least some specimens of correspondences on some higher language level..." (pp.21-22).

These higher levels, according to Vachek, are the word and the morpheme. Examples are cited of homophonous but not homographic words (*right-wright-write*) to illustrate correspondences at the level of the word. On the morphemic level, illustrations are found among grammatical morphemes and stem morphemes. The most well-known grammatical instances are the "Modern English s-endings of the plurals of nouns and of the 3rd person singular present indicative: in both grammatical categories the graphemic shape of the morpheme -(e)s is retained despite the existence of the phonemically different allomorphs /-s/, /-z/, /-iz/, alternating according to well-known morphemic rules of Modern English" (Vachek, p.25). Illustrations are also given of correspondences on the level of the stem morphemes. Here Vachek refers to the work of Bolinger (1946), who argued that there are correspondences of the spoken and written norm on the level of morphemes. In Bolinger's words, "visual morphemes" (by which he meant mainly stem morphemes) "exist at their own level, independently of vocal-auditory morphemes" (1946, p.333).

In light of these principles which conflict with the basic phonemic level (examples were also provided from alphabetic languages other than English), Vachek concludes that "there do not seem to exist written norms based on an exclusive correspondence on one and the same language level. It seems certain, in other words, that all written norms constitute various kinds of compromises between the correspondences established on various levels. Admittedly, in all such types of compromise the correspondence on the basic level (that of phonemes and graphemes) plays some part, and very frequently a major part" (p.25).

Vachek hypothesizes that these nonphonemic conventions in the orthography were a result of a shift in the function of writing which occurred as literacy spread. Again, his words are best quoted here:

> [A]s soon as some scribal tradition develops in a given language community, a tendency emerges aimed at establishing a direct link between the written utterance and the extralingual reality to which it refers. Such a direct link implies that the originally existing detour via the corresponding spoken utterances is becoming gradually abandoned and that, at least to a degree, the written or printed symbols are gradually acquiring the status of signs of the first order... That this is really so is evidenced by the fact of "silent reading", in which an experienced reader can peruse a written page at a much higher speed than if he were actually to read the same text aloud (p.37).

With respect to his observations on the shifting function of writing over the centuries, Vachek further states that

> the structural correspondence linking the spoken and the written norm in one and the same language community need not remain stable in the course of language development but may undergo important changes. In English, e.g., a shift appears to have taken place from the correspondence built up almost exclusively on the basic level (phonemes-graphemes), with some interference of the morphological level, to the present state of things in which the logographic principle has come to play hardly an unimportant part (p.40).

In addition to noting the shifting function of the orthographic system, Vachek notes that the tasks of the reader and the writer differ. Phoneme-grapheme correspondences will be useful to the writer; the reader, however, does not need to transpose written utterances into spoken ones (reading aloud), but is rather faced with a situation which requires "quick silent understanding of the content". The quality of "quick and easy surveyability" enables the utterance "to speak quickly and distinctly to the eyes". For this reason "written norms often deviate from the correspondences on the basic level of language in the direction of logographic and/or morphological correspondences" (p.53). Vachek goes on to suggest that these shifts in the written language may occur with the same lack of awareness as do shifts in pronunciation, and he further suggests that spelling may even signal emotion as in the word initial digraph 'gh-' (*ghastly, ghost, ghetto, ghoul*) which seems to underline the "strongly negative emotional colouring" of the words. This may explain why these particular initial 'gh' spellings were retained while most others were dropped.

From this review of some alternative theoretical views of the English writing system, the discussion now returns to the concerns outlined in Section 2.3.1. Before the questions posed there could be addressed, however, it was necessary to consider the nature of English orthography. What, then, can be concluded from this review? That is, what type of a "system" is the English written language? On the basis of their research, Downing and Leong propose the following:

> The weight of the evidence suggests that English orthography was originally a phonemic notation and that the phonemic principle has been maintained and persists to the present day. The current spelling in English is only partly phonemic because of changes in pronunciation, accidental spelling errors, and deliberate orthographic innovations which have developed other coding principles. Hence, the present-day orthography of English is mainly phonemic... But some other coding principles exist side by side with the phonemic principle (p.82).

Assuming this to be a reasonable characterization of the "system", the question now arises as to what implications this has for the task of mastering English orthography (or what the child will learn in the process of mastering it). It seems probable (assuming the learner has a concept of "phoneme") that awareness of phoneme-grapheme correspondences will play a major role, although, obviously, this "code" is fairly complex (by no means a simple one-to-one relationship) and no doubt appears highly irregular to a child. Most linguistic views agree that English orthography is more than just a phonemic code, but what exactly it codes, and how consistently, is debatable. Venezky, in particular, seems particularly aware of the part played by morphemic considerations in the English writing system. It seems questionable, however, whether the great degree of predictability which he finds inherent in the system will actually be detected and used by the budding literate. It is plausible, however, that the learner develops an awareness of different levels or types of coding in the system and, therefore, there is some reason to suspect that there may be an interaction between spelling (or reading) ability and "morpheme recognition". The degree to which readers and spellers are (or need to be) aware of rules and regularities in the system is largely a mystery, but the issue will be explored briefly in the next sections.

2.3.4 SOUND-SPELLING CORRESPONDENCES

> How on earth do you spell pearl - and don't ask me to look it up in the dictionary because I've already looked under 'pir', 'pur', and 'per' without finding it.
>
> \- a child[2]

In the past several decades there have been a number of attempts to decribe the relationship between (English) spoken and written language in terms of the correspondences between phonemes and graphemes or vice versa. Before any specific examples can be considered, a few points must be clarified. A first point of clarification is that there is a demonstrable divergence in the direction of correspondence which is inherent in the nature of the English orthographic system. Basically, this means that there is asymmetry in the correspondences between graphemes and phonemes, and that what is predictable ~~in~~ the spelling-to-sound direction is not necessarily reversible. While the relationship in either direction is fairly complex, the correspondences as stated in phoneme-to-grapheme direction tend to be considerably less predictable (more ambiguous). The least ambiguity of the whole system is found for consonants in the grapheme-to-phoneme direction, whereas vowels are highly ambiguous in both directions. Other asymmetrical characteristics of the correspondences can also be identified. As Henderson and Chard (1980) note:

> Not only... are the total number of options unequal for the two directions of mapping but for an individual grapheme-phoneme pair the ambiguity of either item

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[2] Quoted in Taylor and Taylor (1983, p.93).

> taken alone is unrelated to that of the other member of the pair. Moreover, there is asymmetry not only in the number of options but in the relative frequency of a given pathway... It follows that a simple translation device that operates in terms of an ordered stack of correspondence frequencies would encounter different difficulties according to the direction of its translation. Furthermore, in the case of whole words, some are irregular (in the relative frequency sense) in one direction but not in the other (p.112).

These characteristics of English orthography are frequently noted in the relevant literature and will not be further explored here. Clear illustrations of the asymmetrical relationships between phonemes and graphemes can be found in Henderson and Chard (1980) and, particularly, Haas (1970), who was concerned with the relation of writing and speech in terms of translatability. This thesis is concerned primarily with spelling productions rather than reading ability and hence, this section will focus on sound-to-spelling correspondences rather than grapheme-to-phoneme relationships. While, obviously, the two are not totally unrelated, the relevant literature indicates that there is little correlation between the ease of spelling and of reading a given word, and the asymmetry of the correspondences noted here may be one reason for this.

At this point, a second clarification is required. That is, a distinction must be made between the tasks of spelling and reading and the processes involved in each. It must be noted that what is said here with respect to phoneme-grapheme correspondences does not necessarily say anything about the task of reading. Research indicates that there are clear differences between the nature of the tasks and the processes involved and that spelling clearly cannot be regarded merely as the "reverse" of the reading process. It is clear, for example, that in addition to the lesser ambiguity of grapheme-phoneme correspondences, a reader may recognize a word on the basis of partial orthographic information, while the speller must accurately reproduce all the necessary letters. Goodman (1976), in fact, describes reading as "a psycholinguistic guessing game" in which the reader gains a good deal of information from the context and utilizes syntactic and semantic information simultaneously with the graphic input. In this view reading does not involve an "exact, detailed, sequential perception and identification of letters, words, spelling patterns and large language units" (p.259), but rather requires "skill in selecting the fewest most productive cues necessary to produce guesses which are right the first time" (p.260) and an anticipation of the content to follow. Clearly, a mastery of the vagaries of conventional English spelling cannot involve such a degree of guess-work.

In addition to the fundamental differences in the nature of the tasks of reading and spelling, there is considerable evidence that the strategies involved in both tasks may change considerably with experience, cognitive development, and familiarity with the system. For example, a speller may initially operate on a limited awareness of sound-letter correspondences. With experience, other strategies may be utilized including analogy with known spellings, deliberate memorization of seemingly idiosyncratic or unmotivated characteristics, and an exploitation of knowledge of morphological relationships. Ehri (1980) also suggests that many successful spellers learn to store printed words as orthographic images which include silent as well as pronounced letters. Clearly, the tasks and processes involved in reading and spelling are complex (and, no doubt, interdependent) and it is beyond the scope and purpose of this thesis to survey and summarize the wealth of literature related to these topics.[3] This section, then, only briefly examines the research into sound-spelling correspondences [4] and considers the role of this knowledge in the overall process of becoming a proficient speller of English.

Without much doubt, the most ambitious and well-known examination of English phoneme-grapheme correspondences is the work of Hanna, Hanna, Hodges, and Rudorf (1966). This study was a "statistical analysis of the degree and the characteristics of the correspondences that exist between the spoken language (using the phoneme as the unit of sound) and the written language (using the grapheme as the unit of encoding)" (p.iii). Hanna et al. conducted a computer search of a 17,000 word corpus which was drawn largely from the Thorndike-Lorge (1944) word lists. They listed the graphemic representations corresponding to each of 52 phonemes taking syllable position (initial, medial, final) and stress into consideration. With the use of these constraints, Hanna et al. claimed that correspondences could be predicted with 84% accuracy. When frequency of graphemic options was used in the absence of stress and position information, predictability fell to 73% (p.109).

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[3] Of the two tasks, there is much less literature devoted to spelling. This is because the serious study of spelling ability is a rather recent development, whereas cognitive psychologists and educators have long been fascinated by the study of reading. One of the most substantial contributions to the study of spelling is the collection of research edited by Frith (1980).

[4] The well-known substantial works of Venezky (1970) and Wijk (1966) are concerned with spelling-to-sound correspondences and will, therefore, not be considered here. Haas (1970) is a monograph which is concerned with the relation of writing and speech and the process of "switching" which takes place between the two language norms. While it is of interest to anyone concerned with written language, it also will not be reviewed here.

In addition to these tabulations, Hanna et al. developed an algorithm which could be used to translate phonemes into their spellings. Information about phonemic content (surrounding phonemes) was added to the predictive factors of syllable position and stress. Morphological constraints were not considered. The resulting system consisted of about 200 "rules" and the power of the algorithm to deal with 17,000 words was then tested. The results (see Table 22, p.119) indicated that 50% could be spelled correctly. A further 36% contained only a single error. A cursory examination of the error lists suggested that many of the misspellings could be accounted for when morphological/etymological factors were considered. For example, *care* was spelled correctly while *caretaker* was spelled *cartaker*. Hanna et al. concluded that English orthography is substantially more systematic than is commonly regarded, but they also made a number of recommendations on the basis of the limitations of their study. Among these, they suggested that the error list produced by the algorithm should be analyzed in order to "identify all of the morphological factors that bear upon these misspellings and to classify all of the misspelled words on the basis of these factors". As well, Hanna et al. suggested that "a study of the relationship between the errors produced by the algorithm and the actual errors produced by children in their spelling efforts would prove interesting" (p.124).

Simon and Simon (1973) conducted a study to compare the performance of the Rudorf (1965) algorithm (cf. the Hanna et al. study) with the actual performance of 50 pupils beginning a fourth-grade spelling course. The student scores and spellings were taken from a pretest given to the students before they had studied the words (except for a few review words). In a test corpus of 48 words, 30 were new to the children, 4 were review words and 14 were labeled 'supplementary'. The results showed that "In all three classes of words, the algorithm made far more errors than the average child. Thus, these fourth grade students spell the words better than the algorithm even before they have studied them explicitly" (p.124).

Although the children could out-perform a computer which was programmed to spell phonemically using the Hanna et al. (1966) rules, Simon and Simon (1973) note that the words which the algorithm misspelled also tended to be difficult for the children. Most of the errors of both the children and the algorithm were made on words that are spelled in a phonetically ambiguous or irregular way. On a sample of 51 "typical" misspellings, Simon and Simon describe a "picture of the nature of typical human errors" as follows:

> In nearly all cases, the typical misspelling implicates a single phoneme. Eighteen misspellings - more than one third - involve a schwa (at least in some pronunciations of the word); eight involve other vowels; nine involve the choice between single and double consonants; three are consonantal errors of other kinds; nine involve homonyms or incorrect inferences from morphemes; and four involve miscellaneous difficulties. Hence, mistaken phonetic spellings predominate, and most of the remaining errors can be described as due to incorrect use of morphemic or semantic information. (p.126)

Simon and Simon claim that this picture of human performance is consistent with evidence from other sources (which they list) and conclude that the ability to use the algorithm would not help fourth grade children spell many of the words that they do not already know how to spell since most of their errors cannot be corrected by phonemic information. They discuss a number of alternative spelling processes which might be used and which could help to explain the superior performance of the children.

2.3.5 SPELLING-MORPHOLOGY CORRESPONDENCES

> You think about words very differently after you know how to write them than before you know how to write them. Being literate has extensive effects upon one's cognitve processes that should be investigated.
>
> (Miller, 1972, p.127)

Although the traditional view of the English writing system held that script was a "visible record of speech sounds", this view was gradually undermined by the observation that the orthography tended to preserve a good deal of morphemic information in violation of the strict phonemic principle. In due time, this observation lead to the development of a number of linguistic descriptions of English orthography in which morphemic or lexical information played a major part (as noted in Section 2.3.3). With respect to these descriptions, Baker (1980) writes:

> Linguists state that the representational principle of English spelling is morphophonemic (Venezky, 1970), systematic phonemic (Chomsky and Halle, 1968), or 'polysystematic' (Albrow, 1972). This latter notion of 'polysystem', or system of systems, in this case the co-existence of and interaction between phonological, grammatical and lexical systems of orthographic representation, derives from the work of J. R. Firth, who stated forty years ago that 'the main argument against phonetic spelling... [is that] it removes phonetic ambiguity and creates other functional ambiguities' (Firth, 1935, p.61f). Similar statements can be found in Albrow (1972, p.8f) and Venezky (1970, p.122f). These writers see English orthography as a naturally evolved device for transcribing, albeit in a somewhat eclectic fashion, linguistic generalizations which may be of value to the reader.
>
> However, all but the most fortunate of English spellers have first-hand familiarity with the existence and persistence of spelling difficulties irrespective of our level of reading attainment; and one is inclined to ask whether the second-order, high-level regularities of English spelling, which may be patent (in both senses, perhaps) to linguists, represent anything other than an obstacle course for the average speller. (p.54)

It does seem apparent (from the literature already reviewed) that there is some relationship between the orthography and morphological structure. What is not nearly so clear is how this "information" may be perceived or utilized by the language learner. At least two questions seem in order here: (1) Just how principled is the "principle" of the preservation of morphemic identity in the orthography? (2) To what degree are language learners aware of this "principle"? There are no obvious answers to these questions and, while the first one may appeal to some formal descriptions for answers, the second is essentially unanswerable at the present time. With respect to these questions, however, a few relevant points may be made.

From the pages of SPE, one would be led to suppose that English orthography is a highly principled ("near optimal") system of lexical representations. According to Chomsky and Halle (1968), the "fundamental principle" of our orthography is that "phonetic variation is not indicated where it is predictable by general rule" (p.49) and is thus not reflected in the spelling. This is an optimal system since the orthography (and the mental lexicon) would then have only one representation for each lexical entry (stem morpheme). As evidence of this fundamental principle Chomsky and Halle made a case for systematic vowel shifts between related words where the change in sound was not reflected in the spelling (e.g. *profane-profanity, divine-divinity, serene-serenity,* etc.). These examples presumably illustrated the systematic and felicitous nature of the English orthographic system.

This idea of English spelling as a lexical system was adopted (from SPE) and further expounded by Carol Chomsky (1970). C. Chomsky contends that English is essentially a lexical system of spelling rather a phonetic system and gives many examples of morphologically related words where sound changes are not reflected in the spellings. Both vowel (e.g. *nation-national*) and consonant (e.g. *medicate-medicine, grade-gradual, quest-question*) alternations are used to illustrate the principle of lexical representation in the English orthographic system.

While English orthography clearly does contain many cases where morphemic identity is preserved in the spelling, there is reason to suspect that this tendency is somewhat less principled than the Chomskys suggest. Moskowitz (1973), for example, notes that the type of word pairs that show alternating vowels in SPE constitute a small percentage of the total vocabulary. In addition, many of these words occur only rarely in speech, as they are among the most "literary" type of words in the language. A few other complicating factors can also be identified for the all-important vowel shift phenomenon. Some semantically related word-pairs, for example, do not exhibit VS, as in the case of *obese-obesity*. It is possible, however, to find other word pairs which are not related (semantically/historically) which could be said to follow the phonological pattern of VS: *comply-complicity, suppose-suppository, rape-rapture* (cf. Taylor and Taylor, 1983, p.105).

One problem for the view that English is a principled system of lexical representation is the very characteristic of the system that the Chomskys use to argue for their position. That is, as Taylor and Taylor (1983) note, "English seems prone to sound changes: A slight variation in word form such as adding a suffix, causes shifts in vowels, consonants, and stress" (p.105). Sometimes morphemic identity is preserved in the spelling when the pronunciation changes. At other times, however, the change in sound is reflected in the spelling even when it would (in theory) be possible to write a rule that would predict the sound change. For example, English contains many word pairs like the following: *delude-delusion, decide-decision, extend-extension, describe-description, pronounce-pronunciation explain-explanation*, etc. In addition, there are a good many English word pairs where the spelling seems to be an arbitrary mixture between the principles of morphemic identity and phonemic representation, as in the examples of *message-messenger, number-numerous, sheep-shepherd*, etc. In general, it would appear that English orthography is not a "principled" system either in the sense of being primarily a lexical or a phonemic system. Rather, it appears to be a curious combination between the two which sometimes does not reflect information at either level. This is not entirely surprising considering the historical development of the written language.

At this point, the psycholinguistic question raised earlier in this section should be briefly considered, namely: how (or to what degree) is the morphological information contained in the orthography perceived or utilized by the language learner? There are at least two (seemingly) converse questions implicit in this larger question: (1) What role does knowledge of derivational relations play in the learning of spelling? (2) What role does the knowledge of English spellings play in the perception of derivational relations? While the answers to both of these questions will have important implications for the field of psycholinguistics, this thesis is primarily concerned with the latter question. A few points, however, may be made here with respect to the first question.

On the assumption that English orthography is essentially a system which preserves lexical spellings in related words, C. Chomsky (1970) suggested that a spelling program should be built around families of related words. Thus, if a student learned that several words had the same lexical base, this would help him resolve ambiguities. For example, the schwa in *president* would not be misspelled if the student knew that *preside* was a related word. In Chomsky's words, "We do not have to memorize the spellings of *declaration, inspiration,* and *adoration,* but merely be able to make the connection in each case to the related verb. Once the connection is clear, the correct spelling is automatic" (p.74).

While this method of mastering English spellings clearly appears to have some usefulness, it does have its limitations, since, as already noted, English spelling does not seem to be as "principled" as Chomsky suggests. Simon and Simon (1973) (cf. Section 2.3.4) point out at least two difficulties with the proposal. First, it can be applied to relatively few words in the whole system. Secondly, it can lead the speller astray, as such analogies will often lead to misspellings (e.g. *remember-*rememberance; proceed-*proceedure; abstain-*abstainence*). Frith (1980) also suggests that there are pitfalls where relationships could give misleading cues. For example, "*pronunciation*, which might be spelled *pronounciation* as it relates to *pronounce; spatial*, which might be spelled *spacial* as it relates to *space*; *deceit*, which might be spelled *deceipt* as it relates to *deception*" (p.504). In addition, Frith notes that this type of knowledge can often come only by "hindsight". For example, "one should theoretically know how to spell *nation* (rather than *nashen*) because of the morphological relationship to *native*; on the other hand, one probably only knows about the relationship because one can spell *nation*" (p.504). This leads to a consideration of the second psycholinguistic question which is more directly related to the goals of this thesis; namely, "What role does the knowledge of English spellings play in the perception of derivational relations?"

Given the nature of the English orthographic system and the fact that the relationships between historically related words may be disguised in the phonetic forms but apparent in the orthographic renditions, there is the possibility that speakers may gain knowledge about morphological relationships as they master particular spellings. Of course, knowledge of a transparent orthographic form will not necessarily lead to perception of a morpheme within a derived word; if the semantic relationship is not apparent, the speller may simply be mastering what may have seemed to be yet another arbitrary convention. The letters in many words correspond to "phonemic" transcriptions for the most part, so it may only be a case of learning one or two letters in a spelling that do not seem to be motivated by a knowledge of phoneme-grapheme correspondences. A speller, for example, may be perfectly capable of producing the correct orthographic forms for both of the historically related words *heal* and *health* and yet have no conception of a morphological relationship between the two. In a SPE account, the ideal speaker-learner's mental representation for *health* would probably contain the same lexical entry as that for *heal* (since the argument goes that the orthographic form of a word corresponds approximately to the way the word is represented in the mental lexicon). There is, however, no empirical evidence that VS forms like *heal-health* are morphologically related for the average speaker-hearer. If the relationship was suggested to the literate speaker, though, it may appear obvious in retrospect, since the orthographic evidence is clear and the semantic relationship is not obscure.

The literature reviewed in Section 2.2.1 suggested that phonological judgements may be shaped or influenced by orthographic knowledge. The question can also be raised, then, as to whether knowledge of particular spellings influences the perception of derivational relations. Miller (1972, p.127) suggests that a writing system that refers to a morphological level affects our perception of the language system (see quote at the beginning of this section). While this hypothesis has a number of interesting implications, it is, unfortunately, not directly amenable to investigation, since the attainment of literacy is generally accompanied by many other intractable variables. It may be possible, however, to probe the differences in perceptions (of derivational relationships) between spellers and non-spellers of particular items (while controlling for factors such as age and similar educational backgrounds). This topic has been the object of very little research and this is no doubt due to the problems which are inherent in the empirical investigation of English derivational morphology. Some of these problems and existing relevant studies are considered in the next section.

2.4 ENGLISH WORD FORMATION; DERIVATIONAL MORPHOLOGY

> [T]he intricate topic of word formation... is one of the least understood chapters in linguistics.
> (Halle and Keyser, 1971)[5]

2.4.1 DEFINING THE PSYCHOLINGUISTIC PROBLEMS

Word formation has been called the "deepest, most secret part of language" (Wilhelm von Humboldt) and, according to Bauer (1983), this is still an apt characterization, since major questions are still unanswered and "...it is obvious just how much research there still is to be done in word-formation..." (p.296). There is, at present, no single coherent "theory of word-formation" and, as Bauer notes, there is not even "agreement on the kind of data that is relevant for the construction of such a theory.... [V]irtually any theoretical statement about word-formation is controversial" (p.1).

One problem which has plagued the formalization of a theory is that of lexical identity (this includes the definition of the "morpheme" and the difficulty of determining morpheme relatedness between words). Linguists have frequently appealed to historical considerations in their discussions of derivational morphology or simply assumed the relevance of this information in constructing their grammars (as in the case of SPE).

There are, of course, some rather obvious problems with invoking diachronic knowledge in a synchronic analysis. For example, if words were analyzed etymologically, the word *disease* would be said to have two components. However, the contemporary meaning of *disease* bears little relationship to the historical combinaiton of *dis-* and *ease* (example from

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[5] Quoted in Strauss, S. L. (1980, p.93).

Bolinger, 1948). The problem becomes even more unmanageable if one wishes to account for historically related morphophonemic alternations between words by positing a single underlying morpheme from which the surface phonetic strings can be derived. This is essentially what the generative phonologists attempted to do by devising a set of rules which would produce the correct surface forms from abstract underlying representations (there do not appear to be any formal restrictions on the upper limits of abstractness in the classical theory) which an ideal speaker-listener presumably possessed. One reason why a phonology of this type can be made to "work" is that the decisions about which words are derived from the same underlying morpheme seem to be quite arbitrary (specifically selected because they are historically related and exhibit a select set of phonological alternations). This criterion, however, seriously undermines the foundations of the theory since, as Bauer (1983) notes, "there does not appear to be any principled way to decide under what conditions two surface phonetic strings should be derived from the same underlying morpheme, that is, when the rules of phonology should predict a given alternation, and when they should not, and consequently, when words should be considered as being linked by a process of word-formation" (p.130). Consider the following pairs of historically related words (taken from Bauer, 1983, p.130):

orange	orange juice
love	lover
medicine	medicinal
malign	malignant
doubt	dubious
young	youth
holy	holiday
acre	agriculture
moon	menstrual
duke	seduce
dear	dearth
rule	regular
gonads	germ
doff	hacienda

From this small sample of words, it is clearly illustrated that etymology, in and of itself, would not seem to be a very reliable guide to word relatedness since these relationships can be anywhere on a gradient from transparent to completely opaque. Not even the most fanatic folk etymologist, for example, would be likely to construe a relationship between *doff* and *hacienda*, though both are ultimately derived from a common source, namely, Latin *facere* 'to do'. If the intuitions of native (educated) speakers were to be taken as the guideline to relatedness, the cut-off point is likely to be somewhere around *holy-holiday*. Unfortunately, as Bauer notes, "the cut-off point is likely to be in different places for different people" and "native speakers' intuitions are also capable of linking forms which are etymologically unrelated, such as *limb* and *limber* " (p.132).

There are no simple solutions to this problem of lexical identity and, in addition, the study of derivational morphology is confounded with the related problem of productivity. As Aronoff (1976) notes "... productivity is one of the central mysteries of derivational morphology. It is the root of the strange and persistent fact that, though many things are possible in morphology, some are more possible than others" (p.35). In light of these and other problems, it is not surprising that the study of English word formation has always been very much a descriptive science, intent on extracting and taxonomically describing patterns and frequencies of occurrences. It is only relatively recently that psycholinguistic considerations have been brought to bear upon the study of English derivational morphology.

The problem of lexical identity with respect to psycholinguistic issues is discussed in some detail in Derwing (1973, pp.122-6). A main point of this discussion concerns the legitimacy of using historical information in synchronic linguistic analyses. This practice presupposes "that the facts of morpheme relatedness (or identity) are known in advance to the analyst and/or the child" (p.122) and that there is a synchronic relationship between forms which may, in fact, be obscure to the average speaker-hearer. Unlike the linguist (who has access to historical information), the child "...must rely solely on such things as *the facts of language use* and *the degree of phonetic similarity between forms* to guide him on the issue of 'relatedness'" (p.122) and hence, the assumption that both child and linguist should come to the same conclusions about morphological relationships is unwarranted. While there are clearly some reasons for believing that children must learn some morphological generalizations, it is not at all clear *which* ones they learn and it is quite possible that any *particular* form could be learned as a separate and distinct lexical item.

In addition to stating the problem in psycholinguistic terms, Derwing notes that the problem of determining morphological relationships has both *qualitative* and *quantitative* aspects. In qualitative terms, the problem is to determine how similar (semantically and phonetically) two forms have to be before they should be considered to be "related". The quantitative problem is to address the question of "How *many* forms... of the requisite degree of semantic-phonetic correspondence are required in order to establish a pattern (for the child) or justify (for the linguist) the restructuring of the lexicon in favor of a new rule?" (p.125). These questions are unanswered and require empirical investigation. It cannot be assumed, even when the putative relationships are transparent to the linguist, that the child has an awareness of the relatedness of these forms. This is all the more true in cases where the semantic and/or phonetic similarities between the putative 'variants' is not obvious and even adult intuitions can vary radically. It may be that, synchronically speaking, many 'morphological relationships' are obscure to begin with and the existence of folk etymologies attests to this. It would appear that "Failure to recognize true (diachronic) morphological relationships is thus part and parcel of (synchronic) language acquisition and contributes to the process of language change itself" (p.126).

2.4.2 EMPIRICAL APPROACHES TO "MORPHEME RECOGNITION"

It is clear, from a psycholinguistic viewpoint, that the problem of "morpheme recognition" requires empirical investigation if we are to understand anything about the ordinary speaker's acquisition of morphology. As Derwing and Baker (1986) state:

> Perhaps the most ignored topic in the study of morphological development is, in the last analysis, the most fundamental one: the assessment of the child's ability to recognise morphemes or to make judgements about morphological relationships.(p.327)

The remainder of this section briefly reviews the existing empirical approaches to the "morpheme recognition" problem.

Perhaps the first (certainly the most well-known) documented attempt to assess children's knowledge of English morphology is that of Berko (1958). Berko's study was concerned primarily with inflectional morphology but she also introduced a technique for probing knowledge of derivational relationships. In order to determine whether a child (four to seven years of age) was aware of separate morphemes in compound words (e.g., *afternoon, airplane, birthday, breakfast, blackboard, handkerchief, Thanksgiving*), Berko proposed asking him why he thought a particular word had the name it did (1958, p.157). In response to this type of question, Berko found that the children's explanations fell roughly into four categories: (1) an *identity* response (e.g. 'a blackboard is called a blackboard because it is a blackboard'), (2) a *functional* response (e.g. 'a blackboard is called a blackboard because you write on it'), (3) a *salient feature* response (e.g. 'a blackboard is called a blackboard because it is black'), and (4) an *etymological* response (e.g. 'Thanksgiving is called Thanksgiving because the pilgrims gave thanks,' etc.). Only the last category of the 'etymological' response gave positive evidence that the child was aware of the derived nature of a word, although the third category answers often approximated the etymological explanations. Berko also found that many children had what amounted to "private meanings for many compound words" and that "these meanings may be unrelated to the word's history" (p.169). Other than these observations, however, Berko did not further investigate the area of derivational morphology, since these considerations were tangential to her primary purpose of investigating the child's grasp of English morphological (inflectional) rules.

It was almost two decades after the publishing of the original Berko study that the empirical investigation of "morpheme recognition" in "derived" words was taken up again. Derwing (1976) replicated Berko's study and also devised some additional techniques for probing knowledge of morphological relationships. The details of this research are described in that paper and further expansions and summaries of the original work can be found in Derwing and Baker (1977, 1979, and 1986) and Derwing and Nearey (1986).

As an initial approach to assessing the psychological validity of morphological analysis, Derwing (1976) investigated the role of semantic and phonetic similarity in the ability of native English speakers to identify common 'morphemes' among pairs of words. Since the psychological recognition of morphological relatedness is generally assumed to be critically dependent upon the degree of semantic and phonetic similarity of the word-pairs involved, the first step was to establish some empirical measure of these two independent variables. In order to do this, a list of 115 potentially related word-pairs was constructed. A broad range of estimated semantic and phonetic similarity was represented among the word-pairs which were largely restricted to five derivational categories. Each of the word pairs was then rated by 129 adult subjects as to the extent of their similarity in meaning. The scale ranged from 0 (no connection in meaning whatsoever between the two words) to 4 (a clear and unmistakable connection in meaning). Judgements as to the extent of similarity in sound (on a scale of 0-6) were obtained from 127 adult subjects.

In addition to the information gained from native speaker judgements, two theoretical indices of phonetic similarity between word-pairs were devised (based on the indices first proposed by Vitz and Winkler, 1973). These indices compared the number of shared phonemes between the words in each pair in an attempt to predict ratings of judged 'similarity of sound'. As well, a grapheme index was devised (based on the number of shared letters in the standard spellings) which was intended as a means of obtaining an estimate of the extent to which orthographic considerations might be affecting judgements. Both of the phonemic models were found to be highly predictive of performance on the phonetic similarity test. The same was true of the grapheme model, but to a lesser extent. Various correlations indicated that prominence was attached more to phonetic than to orthographic similarity.

On the basis of the results obtained from the phonetic-semantic similarity judgements, 50 items were selected to be tested in a replication of the Berko study. The 50 items (which represented the full range of semantic and phonetic similarity involved) were randomized and presented to 95 subjects (40 children, 28 adolescents and 27 adults) using the test frame originally proposed by Berko.

An examination of the resulting data revealed four frequent types of responses: (1) a correct etymological response, in which the subject revealed the historically correct 'base morpheme'; (2) a historically false or 'folk' etymological response; (3) an identity response; (4) a definitional or functional response. Type one responses were taken to express psychologically valid morphological relationships and the percentage of these responses for each item were tabulated. The result of these tabulations proved to be inconsistent with the results of the semantic and phonetic similarity judgements. The overall correlation of the rate of relevant response to degree of semantic similarity was only .57, and for phonetic similarity a non-significant correlation of .17 was found.

Since the results of the two tests were so inconsistent, the experimental techniques were re-examined. It was found that the semantic similarity test took no account of the possibility of ambiguities (e.g., a word like *tumbler* or *buggy* could have more than one interpretation). This did not appear, however, to have been a particularly serious factor as far as the study was concerned. It was also noted that the phonetic similarity indices were contaminated to some extent by the variable of orthographic similarity and it was suggested that the phonetic similarity test be replicated using aural rather than visual stimuli. The main problem, however, was found to be inherent in the Berko test for 'morpheme recognition'. While an appropriate etymological response was taken to be a valid indicator of morpheme recognition, it was noted that a subject's *failure* to provide such a response was not necessarily indicative of his *lack* of cognizance of morphological relationships. It was concluded that "The main difficulty with Berko's technique... is that it allows for far too much variety in the types of responses which it can quite sensibly elicit and thus does not necessarily require subjects to look for morphological relationships at all. To the extent that this is true, therefore, Berko's technique fails to tap the 'morpheme recognition' issue, and is hence invalid as a technique for doing so" (p.50).

In an attempt to correct this defect in methodology, Derwing (1976) devised a new technique to assess the naive subject's ability to identify morphological relationships. This experimental technique was comprised of two tasks. These two tasks were (1) to judge whether one word of each pair (generally the morphologically more complex word) 'came from' the other (using a five point scale ranging from 'No doubt' to 'No way') and (b) to state whether the possibility of the relationship between the words had ever been considered, previously ('Yes', 'Not sure', or 'No').

The results of this study showed that this measurement of 'morpheme recognition' was very highly related to semantic similarity, but less so to phonetic similarity and, therefore, the semantic dimension was the more important of the two. Other correlations indicated that subjects who saw clear morphological relationships between word pairs tended to believe that they had thought of the relationship previously, although there was a bias in the direction of *accepting* proposed morphological relationships even if they had never considered the possibility before. On the basis of the overall results, Derwing was able to develop a criterion which allowed him to graph the 'morpheme recognition' of any particular word-pair in terms of their measures of semantic and phonetic similarity.

Since Derwing's original tests of 'morpheme recognition' were conducted, a number of follow-up studies have clarified the results and added some new insights. The publications noted above further expound and summarize these findings. Only a few points which are particularly relevant to the interests of this thesis will be noted here.

In a publication concerned with the acquisition of English morphology, Derwing and Baker (1979) discuss some indications of the developmental sequence involved in the area of morpheme recognition. They conducted a follow-up study with the expectation that "those morphological relationships which were the most obvious to most adults ought also to be the ones most easily recognized by children and, hence, the earlier they ought to be identified" (p.218). The study employed 50 word-pairs and a subject sample consisting of 120 children (in controlled groups from elementary grades through high school) and 65 adults (university students). Using the Derwing (1976) measurements for morpheme recognition, the results reflected a "generally increased capacity for morpheme recognition in the more mature subjects, who tend to give higher ratings to more and more items" (p.221). Some of the differences in ratings, it is noted, could be the result of specific etymological knowledge acquired in school. There were, however, some notable exceptions to the general developmental trend since there was a tendency for young children to identify potential morphological relationships on the basis of a single dimension (provided that the relationship could be rated fairly high on that dimension). In light of these and other observations, Derwing and Baker conclude that "...'morpheme recognition', at least as measured in this study, may well be a skill which is acquired as much through formal education (as by learning to read) as through the ordinary process of learning to speak and to understand one's language" (1979:223).

In two recent publications (Derwing and Baker, 1986; Derwing and Nearey, 1986), it is noted that the main findings indicated so far in this section are preserved over a variety of different methodological approaches. In particular, all the reported studies reinforce the impression that there is a critical region for morpheme recognition, as determined by the variables of semantic and phonetic similarity. The semantic relationship, however, is easily the more critical of the two and considerable 'slippage' is allowed on the phonetic dimension so long as a clear semantic connection can be made. In addition to this established finding, evidence was found for other influential variables which are of considerable interest to this thesis. It is noted that these variables must play a role in these morpheme recognition tasks but that the extent of their various influences has yet to be explored. The following list of these variables is extracted from these two publications (pp.329 and 196, respectiveiy): (1) The type of construction involved, for example, noun compounds such as ***birdhouse***, which are influenced by sound and meaning similarity in a different way from deverbative constructions such as ***teacher***; (2) the frequency either of the members of the word-pair or of the type of construction; (3) ambiguity, for example, the possibility of either a nominal or adjectival interpretation for the word ***buggy***; (4) variations in the construction types themselves (such that the judged analyzability of a word appears to be influenced not merely by the transparency of the supposed root, but also by such factors as the productivity of the supposed affix added to it); (5) orthographic similarity (yielding abnormally high recognition rates for such pairs as ***breakfast-break*** and ***handkerchief-hand***); (6) educational experience, intelligence and other such subject-specific factors (including knowledge of specific word etymologies, as with ***month-moon*** and ***Halloween-holy***).

From a review of the relevant literature on assessing the awareness of morphological relationships, several points become apparent. First, the semantic similarity of the word-pairs is the most critical factor in "morpheme recognition". Secondly, the perceived semantic similarity for the literate educated adult may differ considerably from that of a child still in the earlier stages of becoming literate and educated. In effect, literate adults may be using different criteria than pre-literates for their semantic judgements and these differences may be reflected in or influenced by, any or all of the six variables listed above. Consider the following dialogue between a linguistically sophisticated adult and a seventh-grade girl who was described as being "a child of average intelligence but a poor speller":

> How do you spell "sign"?
>
> S-i-g-h-n
>
> What do you call it when you sign your name?
>
> Your signature

How do you spell "signature"?

S-i-g-n......

Ok. So how do you spell "sign"?

S-i-g-h-n

But you just told me that "signature" begins with S-I-G-N...!

So what's one got to do with the other?

(Carol Chomsky conversing with a child, 1972, p.77)

It is obvious here that the adult's perception of semantic similarity differs considerably from the child's. No doubt, however, this child, too, would be able to identify a "*sign*" in "*signature*" at the termination of this conversation (assuming the correct spelling was learned and the relationship was pointed out). One relevant question that can be raised, then, is the following: What role does educationally derived knowledge (particularly knowledge of particular spellings) play in the awareness of morphological relationships? Of course, one would not expect that knowledge of spelling in itself would lead to the perception of a relationship if there were no clear basis for a semantic connection. For example, one would not expect literate adults to think that there was a morpheme "*table*" in "*vegetable*" or a "*ham*" in "*hammer*" or even a "*heal*" in "*health*" (a historically related pair) since the words were no doubt acquired separately and the status of the affix "-th" is problematic (see variable (4) above). It is possible, however, that an awareness of some morphological relationships does arise (or is made possible) only with an awareness of the orthographic structure of a particular word. This would most likely happen with words where the orthographic relationship is clear but the semantic relationship is somewhat less than transparent (though not totally obscure). To date, there is virtually no empirical research which has attempted to address this issue and this thesis is intended to help fill that gap.

3. EXPERIMENTAL PROCEDURES AND RESULTS

3.1 INTRODUCTORY REMARKS

The objective of this study is twofold. The first objective is to develop an enhanced method for probing and assessing morpheme recognition, or the perception of morphological relationships between various "roots" and "derived" words. This technique is methodologically interesting in its own right since very little research exists which has attempted to address the question of whether potentially relatable words are, in fact, psychologically related for naive native speakers and, to date, no established techniques exist for probing this knowledge. Developing some methodology to address this issue, then, would appear to be an important preliminary step if one is to seriously address the question which Derwing (1976, p.39) suggests is one of the main problems in derivational morphology; that is, "... to what extent is the linguist's penchant for detailed morphemic analysis realized psychologically by the ordinary language learner?"

The second objective of this study is to gain insight into the nature of the relationship between a child's knowledge of spelling and his awareness of various word relationships. More specifically, the goal is to examine the extent to which the ability to recognize morphemes in "derived" words is correlated with the ability to spell these words. It is hypothesized that, for certain words, a knowledge of the spelling may play an important role in the ability to recognize potential "roots". This is most likely to become a factor with words which are semantically/phonologically distanced from an etymological root which is orthographically preserved as in the examples of the *break* in *breakfast*, the *cup* in *cupboard* or the *hand* in *handkerchief* (cf. Derwing & Nearey, 1986). The following experiment was designed to investigate whether the ability to spell certain words makes any difference for morpheme recognition and, if so, for which "type" of words orthographic knowledge is most crucial. Since both spelling production and morpheme recognition (MR) were being investigated, the experiment consisted of the two main tasks described below.

3.2 TASK 1: SPELLING PRODUCTION

3.2.1 SUBJECTS

The subjects were students in grades 4-7 in Evansdale Elementary School in Edmonton or Corinthia Park School in Leduc, Alberta. Subjects at these levels were chosen since it was crucial to obtain a number of misspellings as well as correct spellings for the stimulus words (described below). The spelling task was administered to a total of nine classes of students (two each of grades 4, 5, 6 and 7 and a single 5-6 split class). All students present were required to participate in the task, regardless of language ability or background. Teachers of the classes were consulted individually to identify students who had ESL backgrounds, who were perceived as having obvious language deficits, who were performing particularily above or below their grade level, or who had failed or skipped a grade.[6] Data from students who were so identified were considered not suitable for the present experiment and were accordingly eliminated from the investigation. The resulting subject pool consisted of a total of 207 subjects distributed in the following way: 57 from grade 4, 52 from grade 5, 59 from grade 6 and 39 from grade 7.

3.2.2 MATERIALS

Sixty pairs of English words were chosen from a larger list of potentially relevant words. One member of the pair was the putative "root" of the second member, which was a putative "derived" word (see Appendix A). Although the selection of these words could be said to be ultimately controlled by arbitrary and subjective motivations, the following considerations were used as guidelines: (1) All word pairs involved spelling similarities that might help transcend less obvious phonological and/or semantic relationships; (2) all words selected were common enough that (according to the best available advice) a student in grades

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[6] Teachers were not always able to identify these students and, consequently, several students who were unsuitable for one or more of these reasons had to be screened out when subjects were selected for the second task.

4 to 7 might reasonably be expected to know them; and (3) the New Iowa Spelling Scale and the Strothers-Minkler Canadian Word List were consulted to determine spelling difficulty; all words chosen were ranked from grades 3 to 8, a range that was selected in order to make it likely that there would be both misspellings and correct spellings in the data base.

The final word list represented varying degrees of orthographic, phonological, and semantic similarity, but was limited to a small number of high frequency derivational affixes, with multiple examples of the nominalizing suffixes -ity and -(t)ion and of the adjective suffixes -(e)ous, -al, and -ful. Twenty five of the 60 words had been used in Derwing's original morpheme recognition study (1976), a feature that allowed some comparison of results. Also represented in the list were pairs that exhibited various vowel shift alternations (see Wang, 1985), ~~derived~~ words which were etymological compounds but are now often viewed as a single morpheme (e.g., *breakfast*, *cupboard*, *handkerchief*), and a few word pairs having a dubious or synchronically false morphological relationship (e.g., *draw-drawer*, *price-precious*, *ear-eerie*, *fry-Friday*, *sting-stingy*, *table-vegetable*).

3.2.3 PROCEDURE

The stimulus words were randomized and presented to each class of subjects in two testing sessions. Thirty words were dictated to the subjects in each session, as some of the teachers felt that the full sixty word list would tax the attention span of the subjects (particularily the grade 4s). The word list for presentation 1 and presentation 2 was the same for each class.

In each class, the experimenter introduced herself and explained to the students that she was interested in finding out something about how students at their particular age and grade level spelled certain words and whether or not they knew the meanings of these words. Students were assured that this was not a test and that they were not going to be graded (Students were given this assurance because some teachers had expressed concern for the self-esteem of students if they were required to spell words which were too difficult for them). They were told that 30 words would be dictated to them and that the experimenter would say the word three times altogether. The word would not be "sounded out" or put into a sentence (as is the normal procedure on many spelling tests). Students were also told that they would find some of the words easy and some quite difficult, but were advised not to get overly concerned if they had particular difficulty with a word or even if they didn't know its meaning, since they were not expected to know the spellings/meanings of all the words. Their task was simply to spell each word as well as they could. Students were asked to print so that their spellings could be read easier and all spellings were written on a response sheet provided (see Appendix B).

After the students had made an attempt to spell all of the words, their attention was directed to the remaining two columns on the answer sheets, which were arranged so that for each word there was a specific place to indicate YES and another place to indicate NO. Students were told that this was where they were to show whether they knew the meanings of the words. It did not matter whether they thought they had spelled the word correctly or incorrectly; the only important thing at this point was whether they knew the meaning of the word or not. If they knew the meaning of the word and thought they could tell someone else what it meant, they were to check YES. If they didn't know what the word meant, they were to check NO. Students were also told that, if they weren't sure and didn't think that they could tell someone else what the word meant, they should check NO. They were assured again that this was not a test and that they were not necessarily expected to know all the words. It was, however, important that they were honest about whether they really knew the meaning of the word or not.

At this point, the experimenter went through several examples on the board. She then told the students that she would read through the list of words again and that they should check either YES or NO for each one. Students were asked to put a check for each word as they heard it and not to go ahead of the examiner. The entire testing session took approximately 30 minutes for each class.

As much as possible, all grades within one school were given the same list of words on the same day, so as to reduce the possibility of information about the words "spreading" from one class to the next. Teachers were also requested that, as much as possible, they not draw any particular attention to any of the stimulus words until all the testing for the second task was completed.

3.2.4 SCORING

Subjects' spellings were first scored dichotomously; that is, as either correct or incorrect. Although a full classification of types of spelling errors would no doubt prove interesting, the development of such a system was considered beyond the scope of this investigation (but see 3.4.1.1 below). A small number of items in the data were scored with a question mark (?). These were cases where the subject's writing could not be clearly made out or the subject had written a different word than the one that had been dictated (e.g. *preacher* instead of *creature* or *covered* instead of *cupboard*).

Subjects' knowledge of word meanings were also intended to be dichotomously scored (YES or NO). There were, however, a few cases in the data where the subject did not put a check or else put it on the line between the two. These cases were given a question mark status (?). Each subject, then, was scored as giving 120 pieces of information — that is, information about his/her knowledge of the spelling and meaning of each of 60 words.

After scoring, the information on spellings and knowledge of word meanings was entered into a computer file and re-scored so that each of the 60 items for each subject was given one of three labels — A, B, or C. "A" in this system refers to a response where the subject indicated that he knew the meaning of the word and spelled the word correctly. A "B" score was used to represent an incorrect spelling where the subject claimed to know the meaning of the word. A response was coded "C" if the subject indicated that he did not know the meaning of the word or if a question mark was encountered in the original coding of an item. Since knowing the meanings of the selected stimulus items was a prerequisite for involvement in the second task, and since it was essential to be clear about what a subject intended, "C" responses were considered unusable for purposes of this study. For each item, then, only "A" or "B" responses were used in conjunction with the data gained from the second task.

3.3 TASK II : MORPHEME RECOGNITION

3.3.1 SELECTION OF SUBJECTS AND STIMULI

Subjects and stimulus items selected for the second task were subsets of the subject groups and stimulus sets described above. Any of the 207 subjects or the 60 words were considered potential candidates for the morpheme recognition (MR) task. Since the MR task was quite elaborate and time consuming, practical considerations demanded that the number of subjects be kept to a minimum. How many subjects were required, however, depended upon the types of responses which occurred for the stimulus items. The original goal was to find a set of some 15 to 30 words for which there was approximately an equal number of A responses and B responses at each grade. This control for grade was seen as essential to prevent a very likely and undesirable confounding factor in the data; that is, most of the misspellings of any particular item were likely to come from the younger subjects in the lower grades, while the older subjects in the higher grades were more likely to produce the correct spellings. Cross-tabulations which show the frequency and percent of the A, B and C responses in each grade for each word were computed and these were examined to identify those words which had approximately an equal number of A and B responses at each grade.

Examination of the tables revealed that some words were spelled too consistently poorly by the younger students to be able to provide any near equal sets of A and B responses, while other words were spelled too consistently well by the older students (i.e., at the 6-7 grade level, most of the responses were of the A type). It was therefore decided to work with two sets of words — one for the subjects in grades 5-6 (Set 1) and one for the subjects in 6-7 (Set 2). To be eligible for either set, a word had to have a minimum of eight A responses and eight B responses at each of the relevant grade levels. Theoretically, then, if a word had a frequency of at least 8 in each cell, it was possible to identify 8 spellers and 8 misspellers for each item at each grade level — although any given subject who was found to be a speller on one item might be a misspeller on any other item, depending on his/her responses.

Given the criterion of a minimum frequency of 8 in each cell, the cross-tabulations were re-examined and each of the 60 stimulus words was placed in one of the following four categories:

1. Stimuli that met criterion for all grades : 8 words
2. Stimuli that met criterion for grades 4-5 : 19 words
3. Stimuli that met criterion for grades 6-7 : 13 words
4. Rejected stimuli (not meeting criterion for either 4-5 group or 6-7 group) : 20 words

The stimulus words that met criterion for all grades subsequently became part of both Set 1 and Set 2. At this point, then, Set 1 (grades 4-5) consisted of 19+8=27 words in total, while set 2 (grades 6-7) consisted of 13+8=21 words in total.

The next task was to choose the optimal group of subjects for 15 or so words from each set. To control for grade, a minimum of 16 subjects were to be chosen from each grade (eight A responses and eight B responses to each selected stimulus item). A minimal group of subjects to participate in Task II would therefore have been a total of 64 subjects. However, it was not possible (or even necessarily desirable) to select subject groups who all responded A or who all responded B to the same 15 items. It was decided, therefore, to look for 8 pairs of mismatched responses (i.e., where one subject responded A, another responded B) for any 15 words at each grade level. A perfect set of mismatches for any 15 items would then look something like the following:

Words:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Subject 1:	A	B	A	B	B	B	B	B	A	A	A	B	B	B	A
Subject 2:	B	A	B	A	A	A	A	A	B	B	B	A	A	A	B

As can be seen from this illustration, the within subject responses were of no concern here. A given subject could have any number of A or B responses to any of the items. The goal was rather to identify a second subject who responded in the opposite way for the same

15 items. If (at each grade level) eight pairs of mismatched responses (A vs. B) could be found for any 15 words, the minimal group of subjects would still total 64 (16 at each grade level).

In order to identify subjects who were likely to have the greatest number of mismatches, a fortran program for distance computation was utilized (see Appendix C). This program calculated the distance between every possible combination of subjects in each grade. For example, in the 4th grade there were 57 subjects and, thus, $n(n-1)/2=1596$ possible comparisons to make. Distances were computed for all these comparisons and the output was arranged hierarchically from the farthest apart (greatest number of mismatches) to the most similar in response (least number of mismatches). In addition to computing and ranking these distances, the program also generated a statement (for each comparison) which indicated the specific items any two subjects were mismatched on.

With this information on distances and mismatches at hand, a chart was set up for each grade showing the eight pairs of subjects which had the greatest number of mismatches (see Appendix D for an example). For each of the items in the word set (listed along the top) a check (✓) was made to indicate where the subjects had mismatched responses. At no grade level was it possible to find 15 complete sets of mismatches by considering only 8 pairs of subjects, so another four pairs of subjects were added to each grade's chart. This made a total of 12 pairs or 24 subjects per grade. With the mismatches provided by these subjects, it was then possible to find 16 items that "met criterion" at the grade 4 level. In other words, there were 16 items for which at least 8 mismatches could be found. Similarily, for 12 pairs of subjects, 19 stimulus items met criterion at the grade 5 level, 12 at the grade 6 level and 16 at the grade 7 level. These 12 pairs of subjects at each grade level thus became the subjects selected to participate in the second task of the study (morpheme recognition). At 24 subjects per grade, there were a total of 96 selected subjects for Task II. No attempt was made to control for the sex, age, or socio-economic status of these subjects.

After the optimal group of subjects had been identified, the final selection of the stimulus items for Task II was determined. Actually, no independent "selection" was involved here, as the outcome was determined by the availability of a prescribed number of A and B responses to each item. Since Grade 4 and Grade 5 had shared the same set of 27 items, the selected items from these grades were compared. When the 16 items that had met criterion for grade 4 were compared with the 19 from grade 5 it was found that there were only 12 items in common. Similarily, Grades 6 and 7 shared a common set of 21 words. When the 12 items that had met criterion for grade 6 were compared to the 16 from grade 7, 11 items were found to be in common. The least interesting item, *wallet* , was then eliminated from the grade 4-5 set in order to make both sets of stimuli equal in number, a step taken primarily for the sake of convenience in setting up programs for further computation and analysis. Both sets of stimuli were thus composed of 11 items, and since there were three items which were common to both sets, a total of 19 stimulus items were utilized between the two sets. The respective sets for the grade 4-5 and the grade 6-7 groups were as follows (where * denotes the three common items):

SET I:
awful
cavity
creature
criminal
cupboard *
drawer *
electricity
messenger *
necklace
president
signal

SET II:
cupboard *
decision
description
discussion
drawer *
fabulous
knowledge
messenger *
pollution
precious
vegetable

3.3.2 PROCEDURE

The morpheme recognition task utilized in this study builds upon the pioneer work described in Section 2.4.2. Elements from the Berko (1958) study and the Derwing (1976) research are combined with a previously untried questioning technique. These elements are integrated in a hierarchical manner, producing an "enhanced" method of probing/testing for

MR which allows for the evaluation of the various types of approaches.

The morpheme recognition task was administered approximately seven weeks after the spelling production task. Once identified, the 96 subjects were divided into groups according to the school and class they were in and the testing of subjects in the same class was done in as concentrated a period of time as possible, so as to reduce the opportunity for discussion of the task among the subjects.

Selected students were individually interviewed by the examiner in a quiet room in the school. Subjects were provided with an answer sheet prepared for their spellings and the examiner had a labeled response sheet for each subject that was used to record the subject's answers to each question asked (see Appendix E). Each subject was given essentially the same directions, as follows:

> I am trying to get some information about how people about your age and grade level think about some words. I am going to ask you some questions about the meanings of these words. This is not a test — I am not trying to tell how smart you are. I am interested in what you really think about the words. Some of the questions I ask you will seem easy to answer; some will seem harder; some may seem like a strange question. I can't give you any feedback, hints, or suggestions. There is not always a "right" answer — I am only interested in what you think. If you don't know or have never thought about the question I ask, that is perfectly O.K. Just say "I don't know " or "I never thought about it." After I ask you about the words, I will ask you to write them (no matter what your answer to the questions may be). The paper you have is to write these words on. Let's try some examples:

The examples used were as follows, with full details supplied to indicate the order of questions and options used for the stimulus items:

EXAMPLE I: (This example was the word pair TEACH-TEACHER which was taken as a clear, uncontroversial case of morphological relatedness.)

Q1. (Definition question) What does the word TEACHER mean to you?

Q2. (Berko-type question) Why is a TEACHER called a TEACHER?

Q3. (CF1) Does the word TEACHER "come from" any other word that you know of?

A. If answer to Q3 is YES:

Q4. Which word?

What does this word mean?

Q5. Why do you think so?

(If subjects seemed uncertain or were unable to give a reason here, they were asked to confirm/ disconfirm with CF2: Do you think that TEACHER comes from the word TEACH?)

Q6. Did you ever think of this before or did you just think of it now that I asked you about these words?

Spell TEACH----------

Spell TEACHER-----------

B. If answer to Q3 is NO or NOT SURE:

Q4. Do you know the word TEACH?[7]

YES	NO
What does it mean?	Questioning terminated.
	Spell TEACH.--------
	Spell TEACHER.--------

Q5.(CF2) Do you think that TEACHER "comes from" the word TEACH?

---

[7] There were several putative roots which were potentially ambiguous (i.e. LACE and DRAW). In these cases, subjects were required to indicate that they knew both meanings. For example, when asked to define DRAW, subjects (almost) invariably gave the meaning used in the phrase "to draw a picture". They were then asked if they knew any other meaning of the word. If they could not think of one, they were asked if they had ever heard of the phrases "to draw a name out of a hat", "to draw water out of a well", or "to draw the drapes". If they indicated that they knew the meaning, they were asked to explain what this word DRAW meant.

YES	NO
Why do you think so?	Questioning terminated.

Q6. (Recall question) Did you ever think of this before or did you just think so now that I asked you about these words?

Spell TEACH.-----------

Spell TEACHER.-----------

EXAMPLE 2: (This example was the word pair HAM-HAMMER, which was taken as a clear case of non-relatedness: though the two words are similar phonologically and orthographically, they are not related, either historically or synchronically.) The questions followed the same general progression as with the first example. Surprisingly, however, a few subjects suggested the word HAM in response to the first "comes from" question (Q3). These subjects were then asked the following questions:

1. What does the word HAM mean?
2. Why do you think the word HAMMER comes from the word HAM? (None were able to think of a plausible reason).
3. Do you think HAM is related to HAMMER like TEACH is related to TEACHER?
4. Do you think that the word HAMMER "comes from" the word HAM or do you think that HAM is a different word that sounds the same?
5. Did you ever think before that HAMMER came from the word HAM — or are you just trying to think of a word now?

At the end of this questioning, all had concluded that HAM was not related to HAMMER but was rather a different word that merely sounded the same. This was the only "coaching" or guidance which subjects received. It was considered essential in the training examples, however, in order to ensure that subjects were aware of the nature of the task and did not simply think that they were always expected to find one word within the other word.

After the examiner was satisfied that the subject understood the task, the testing proceeded with the 11 items in the appropriate stimulus set. The format of the testing was essentially the same as described in the examples above, although each "derived" word required a slightly different Q2 frame. Note also that the questioning procedure varied slightly depending on the subject's response to Q3 and that other contingencies might lead to a termination of questioning without all six questions having been asked. For example, it did not seem relevant to ask subjects whether they thought one word "came from" another or whether they had ever thought of the relationship before if they had already indicated that they did not know the potential "root" and had no idea what it meant. At the conclusion of each session, each subject was thanked for their participation and asked not to discuss the task or words with other students. Each testing session lasted approximately 20 minutes.

3.3.3 SCORING SYSTEMS

Three systems were devised to score the morpheme recognition data.

SYSTEM I: Subjects responses were scored dichotomously on the basis of their responses to Q3 (CF1) and Q6 (Recall) to each item; if both responses were positive, the score was YES — otherwise the score was NO. In other words, if the subjects spontaneously suggested the potential "root" and also indicated that they had thought of the relationship prior to the experiment, they were considered to have perceived a morphological relationship between the pair. If either response was negative (or if the subject gave contradictory information between Q3 and Q6), no morphological relationship was assumed to have been perceived.

SYSTEM II: Each subject was awarded a set of points on the basis of his/her responses. In this system, the maximum number of points to be awarded for any word pair was FIVE. Points were distributed as follows:

ONE point for using the "root" in response to Q1 (Definition).

ONE point for using the "root" in response to Q2 (Berko-type question).

TWO points if the subject suggested that the "derived" word came from the potential "root" and gave a reason why (YES to Q3 plus Q4 &Q5).

ONE point if the experimenter suggested the "root" and the subject indicated that he thought the "derived" word came from it (NO to Q3 plus Q4 & Q5).

ONE point if the subject indicated that he had thought of the relationship before (Q6).

This scoring system allows for the possibility of various degrees of morphological awareness, as reflected in a total score that can in principle vary from 0-5. (Note, however, that a subject can accumulate up to four points in a number of possible ways in this system.)

SYSTEM III: This system was devised in order to differentiate between the various combinations of responses which could result in the same score according to System II and to determine if there were any predominate patterns which occurred for the spellers or the misspellers of each item.[1] A subject's responses to each item were coded in terms of a six-point "profile". These six points were based on the subject's responses to the six questions outlined previously (summarized here for convenience).

Q1. Definition of derived word. (Does the subject use the "root"?)

Q2. Berko-type question. (Is the "root" used?)

Q3. (CF1) Does the derived word "come from" any other word? (Is the "root" indicated?)

Q4. Does the subject know the "root" word? (Confirmed by having the subject define the word.)

Q5. Subjects were given at least one of the following questions: (CF2) Do you think that the derived word comes from the suggested word? (asked if root was not identified in Q3)

Why do you think the derived word comes from the word you suggested? (asked if root was identified in Q3)

Q6. Did the subject ever think of this relationship before?

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[1] Thanks to Dr. W. J. Baker for suggesting this scoring system.

A subject was assigned a score of 1 for every "positive" answer and a score of 0 for every "negative" response. The scores were arranged in a linear fashion with respect to the ordering of the questions. For each stimulus item, then, a subject's responses were coded in terms of a profile which made it possible to see the manner in which the subject accumulated points for morpheme recognition.

Given that a response to any of the six questions can be treated dichotomously, there are $2^6=64$ different profiles which could potentially occur. Appendix F diagrams the logical paths which the questioning could take. Note that, while there are 64 mathematical possibilities, this amount includes a number of logical "dead ends". If a certain type of response never occurs in the data, for example, it eliminates the possibility of several different types of profiles ever occurring. Thus, about half of the possible profiles never occur simply because there is never an instance where a subject who uses the root in response to any of the first three questions later professes not to know the meaning of the root word (negative response to Q4). As well, profiles do not occur because a negative response at a particular juncture leads to a termination of questioning and negative responses to any further questions are then assumed. This would eliminate the possibility of profiles resulting from positive branching from negative terminal nodes. The profile system of scoring the morpheme recognition data, then, accounts for all the logically possible combinations of positive or negative responses to the six questions used. All the types of patterns which occur for any item can be identified and enumerated. As well, this system makes it possible to determine if certain patterns predominate for subjects giving A or B type responses to each item.

Although System I and System II were devised prior to the conception of the profiles, it should be noted that both of these systems can be mapped directly into System III. While there are only a possible five points allotted in System II, the questions correspond exactly to those represented in the six columns of the profiles (System III). The difference between the allotted points in the two systems is accounted for in the fourth column of the profiles. A score of "1" in this column indicates that the subject knew the root. A positive response to

Q4 is implicit in System II, since any subject who did not know the root would automatically have a score of zero. In the profile system, this implicit score is made explicit. The advantage of this is that it allows the distinction of responses like 000000 and 000100, where the first profile shows that the subject does not know the root and hence cannot score any points for morpheme recognition. The latter profile identifies a case where the subject knew the potential root but did not see it as having any relationship to the given "derived" word. In the point system, both of these responses would receive a score of zero.

3.4 ANALYSES AND RESULTS

Data gained from the 96 subjects' responses to the two tasks were analyzed with respect to the two objectives of the study previously outlined. The major part of the analysis was devoted to addressing the question of whether the knowledge of particular spellings influences the ability to recognize potential morphemes in "derived" words. The first section outlined below, then, deals with examining the relationship between spelling and morpheme recognition. All analyses here are neccssarily item by item and no inferences can be made or insights gained with respect to individual subjects or groups of subjects. A "speller" of one stimulus item may have been a "misspeller" of another stimulus item and vice versa. The focus here was on whether there were any significant differences between the spellers and misspellers for each given item. The second section of the data analysis is concerned with evaluating the systems of scoring the morpheme recognition data and of probing the relationships between positive and negative responses to some of the questions utilized in the morpheme recognition task. Again, there is no information here regarding within-subject responses, as groups are defined only in terms of responses given to particular stimulus items.

3.4.1 SPELLING AND MORPHEME RECOGNITION: ITEM ANALYSES

3.4.1.1 SPELLING GROUPS REDEFINED

Groups of spellers and misspellers for each stimulus item had previously been determined by means of a dichotomous scoring system where A represented a correct spelling and B an incorrect spelling. Preliminary analyses (such as t-tests and various crosstabulations) were carried out using this grouping distinction. During the course of these analyses, however, the question was raised as to whether this was in fact the best way to differentiate the spellers vs. the misspellers. Two observations lead to a reconsideration of the notion of "spelling error" in terms of the interests of this study. Firstly, it was noted that, in the derived words, a number of misspellings occurred on the suffixes while the putative root was represented in the correct orthographic form. These misspellings would not seem relevant for MR. A second observation was made when the original spellings of the 96 subjects were compared with their spellings obtained on the second task. Here it was noted that a subject's misspelling of a root in isolation would sometimes correspond with his misspelling of the root within the derived word. Such consistent misspellings might indicate, or lead to, perception of a common morpheme in the two words. In keeping with the hypothesis of the experiment, then, it was decided to redefine the groups in terms of "critical" spelling errors.

Spelling data from the 96 selected subjects who had participated in the morpheme recognition task were rescored by considering both the spelling of the "root" and the spelling of the "derived" words. Where the critical spelling of the root and the derived word corresponded, the subject was given a score of "S" indicating that the critical spellings were the *same*. A score of "D" was used to represent cases where the critical spellings *differed*. A response which was coded "C" in the original scoring system remained a "C" since these were cases where a subject indicated that he did not know the meaning of the word or there was some problem in interpreting the subject's intentions.

The notion of "critical" spelling error was strictly defined for purposes of this experiment. In order to be coded "S", the subject's spelling of the root had to be maximally contained within their spelling of the derived word. Beyond the root, misspelling was considered irrelevant to morpheme recognition. This meant, for example, that spellings which occurred such as CUP/CUPBERD, KNOW/KNOWLGE and LACE/NEKLACE were coded "S". A root or derived word did not have to be spelled correctly, however, so long as the misspellings corresponded for the two words. For example, an "S" coding would include cases like SIGHN/SIGHNAL, CREAT/CREATURE, NO/NOLADGE, PULUT/ PULUTION, and DISCUSE/DISCUSEN. This coding system was quite straightforward in cases where it could be seen that the spelling of the root either was or was not contained in the derived word, although a few spellings still raised some interesting questions. For example, the spelling KNOW/KNOLEGE was coded "D" due to the absence of the "W" in the second word, yet the presence of the silent "K" in both words suggests that an "S" coding might well be more appropriate.

Although the S/D coding system was judged to be theoretically more appropriate than the A/B approach for testing the hypotheses of the experiment, it did lead to a number of difficulties. The first problem was associated with changes in the spelling of the "root" when it occurred within a derived word. While "compound" words (like CUPBOARD and NECKLACE) or words where the "root" is orthographically contained in the derived word (such as KNOWLEDGE, SIGNAL and DRAWER) did not present a problem, other cases were less clear. Where the orthographic presence of the root was not clear cut, a number of cases arose where the scoring system seemed less appropriate. However, in order to maintain consistency, the strictest standard was adopted and applied to all cases. A few of these ambiguous cases can be illustrated here.

The most problematic case for the S/D scoring system was possibly the pair MESSAGE/MESSENGER, whose correct spellings share the sequence MESS...GE, which includes the double consonant and the "silent" final "E." A strict standard of scoring demanded that the spelling of the root and the derived word be maximally equivalent. When this was applied, cases like MESiGE/MESenGEr, MASeGE/MASanGEr, and

MESSiGE/MESSinGEr were coded "S" while cases like MESaG/MESSaGEr, MESiG/MESSanGEr and MESSaG/MESSenGEr were coded "D". It is not obvious here that the first set of misspellings holds any real advantages over the second as far as morpheme recognition is concerned.

Other words which presented problems were those that had similar orthographic characteristics to those of MESSENGER: that is, they contained double consonants or the letters of the root were not completely contained in the derived word. In the former case, the strict standard required that spellings like DISCUSS/DISCUSION or POLLUTE/POLUTION be scored as "D", although this would not seem to present the same sort of problems for morpheme recognition as misspellings like DRAW/DROOR or CREAT/CRECHER. The question of the continuity of spelling sequences can also be raised. For example, the common spelling of DECIDE/DECISION is DECI. Having these letters in common, however, did not necessarily lead to an "S" coding if the letters were interrupted in any way. Thus, the spellings DECIDE/DESCION were coded "D", while the spellings DESIDE/DESISION were coded "S", since they shared a common uninterrupted sequence.

In addition to the problematic scoring cases discussed here, the adoption of the S/D scoring system at the analysis stage resulted in a situation of an unequal number of subjects in the groups of those who made critical spelling errors and those who did not. Subjects and stimulus items for the second task had been selected concurrently on the basis of the A/B distinction. Under the revised scoring system, equal numbers of S and D subjects did not result. Interestingly, the subject numbers in the groups for most items which contained a transparent orthographic root did not change greatly. Other items, however, were virtually eliminated from useful grouping analyses. This was the fate of CRIME/CRIMINAL and CAVE/CAVITY at the grade 4-5 level and of TABLE/VEGETABLE and FABLE/FABULOUS at the grade 6-7 level. In all of these cases, the critical letters are more or less the plausible choices based on a knowledge of phoneme-grapheme correspondences; when spelling errors on non-critical letters were eliminated, therefore, most subjects fell into the "S" category. All other stimulus items retained a reasonable number of subjects in each of the S and D groups so that meaningful analyses could be carried out, provided that appropriate statistical measures were taken to adjust for unequal subject groups.

3.4.1.2 PRELIMINARY ANALYSIS

The first analysis which was carried out was intended as a preliminary probe to see if any significant differences could be identified between the groups of spellers and misspellers of each item. The groups were first defined as A/B and, secondly, as S/D. T-tests were used to compare the means of the points awarded for morpheme recognition (System II). A t-test was calculated for each stimulus item in the grade 4-5 set as well as each item in the grade 6-7 set. Recall that both sets of stimuli consisted of 11 items and that the three items CUPBOARD, DRAWER, and MESSENGER were common to both sets. The significant results obtained for the A/B groups and the S/D groups were very similar. The same items were identified with the only difference being that, with one exception, the S/D groupings yielded higher levels of significance. The significant results of the two sets of stimulus items are as follows:

GRADE 4-5: Levels of Significance (After Yates Correction)

ITEM	A/B Grouping	S/D Grouping
Cupboard	0.001	0.000
Drawer	0.052	0.001
Necklace	0.028	0.001
GRADE 6-7:		
Cupboard	0.000	0.000
Drawer	0.000	0.000
Discussion	0.000	0.025
Knowledge	0.002	0.001

Although significant results were obtained for only a few items in each set, the levels of significance are very high suggesting that, for these items, real differences exist between the spellers and misspellers (defined as either A/B or S/D). Also of importance is the fact that the two items CUPBOARD and DRAWER which were common to both sets have high levels of significance at all grade levels. The significance of the difference between the groups in fact increases for the item DRAWER from the grade 4-5 level to the grade 6-7 level.

These results suggest that a knowledge of a word's spelling may be an important factor in morpheme recognition (MR) for the particular types of words identified here. Note that for all the words for which significant results were obtained, the "root" is completely present orthographically in the "derived" word while, at least in most cases, the semantic/phonological relationships are somewhat less clear.

While it is tempting to make the obvious conclusion suggested here, certain difficulties associated with this analysis must be confronted. The main difficulty is associated with the assumptions implicit in the scoring system. If a subject's overall score reflects a "degree" of morphological awareness, the t-tests are appropriate and valid. However, there is the possibility that important distinctions are obscured by this treatment. As noted previously, a subject could have accumulated up to four (out of a possible five) points in a number of ways in this system. There is, therefore, no distinction here between various combinations of points which may represent significantly different types of responses or, possibly, different strategies. Information on how the points were accumulated was contained in the profiles and this information was utilized to further probe the question of the importance of spelling knowledge for morpheme recognition.

3.4.1.3 GROUPED ANALYSES

This section outlines the grouped analyses which were carried out and the significant results which were obtained for each. All manipulations of the data and the various computations for the analyses were obtained by using the statistical package SPSSx. In all cases, only the S/D distinction was used to define the groups of spellers and misspellers. For all Chi-square tests, the significance levels reported are those obtained after Yates correction which adjusts for small expected frequencies in some of the cells.

The first question addressed after the initial t-test probe was whether any of the items exhibited differences between the groups when morpheme recognition was strictly defined as positive responses to what were considered to be crucial questions. For each item, a Chi-square test was preformed on the groups S and D for the responses YES (a morphological relationship was perceived) and NO (no perception of morphological relationship was indicated). "YES" here was defined as a profile indicating positive responses to the last four of the six MR questions (i.e. a profile of the form xx1111 where an "x" indicates that a response is free to vary). This profile identifies a subject who knew the meaning of the root, suggested the root in response to the first "Comes From" question, confirmed that he thought that the given derived word came from the root, and indicated that he had thought of the relationship prior to the experiment. Responses to the "Definition" and the "Berko" questions were free to vary as these were not considered necessarily indicative of morpheme recognition[9]. "NO" responses were defined as all other profiles.

Although "YES" in this analysis was defined in terms of the profiles, it should be noted that this coding is exactly equivalent to the coding system as described in the first scoring system (YES=positive responses to Q3 and Q6). This can be verified with an examination of Table 1 (pg.---) where it can be observed that all profiles of the form xx1xx1 correspond to the pattern xx1111. In other words, any subject who responded positively to Q3 and Q6, knew the root (Q4) and also responded positively to Q5. There is, therefore, no discrepancy between the YES/NO of System I and the definitions of YES/NO as described for this analysis. The analysis yielded few significant results, however. At all grade levels, the only item to show a significant relationship between the spelling groups for morpheme recognition was the word CUPBOARD which increased in significance from p=0.0455 at the grade 4-5 level to p=0.000 at the grade 6-7 level.

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[9] This decision was made on the basis of Derwing's 1976 MR test results where it was suggested that Berko's technique allowed far too much variety in the types of responses which it could sensibly elicit and thus did not necessarily require subjects to look for morphological relationships at all. This finding is verified in section 3.4.2.3 below where it is shown that Q1 and Q2 do not correlate well with Q3 and Q6.

The next question to be addressed concerned the relationship between the spelling groups and the scores which were awarded for morpheme recognition according to System II. A subject's score for each item was computer re-scored as HIGH (H) if it was any of 3-5 points inclusive. LOW (L) scores were those ranging from 0-2 points. A Chi-square test was then performed on each item for the S/D groups and the response scores H/L. This analysis utilized the same MR scoring system as was involved for the t-tests and, therefore, was also beset with the problem associated with the point system. That is, although a subject must receive a score of at least 3 (out of a maximum of 5 points) to receive a coding of YES for MR, a score of three or four does not necessarily identify a case of qualified morpheme recognition. The main reason for this analysis, however, was to compare the results obtained to those of the previous analysis (the YES/NO Chi-Squares) where morpheme recognition had been strictly defined as positive responses to particular questions. If the results of both analyses corresponded, it could be said that most of the HIGH scores are YES responses. However, in light of the results of the t-tests, it was expected that the results of this analysis would overlap, but not correspond to, the results of the previous analysis.

When the Chi-square tests were calculated for the S/D groups and the H/L scores, the results confirmed expectations; that is, the results of the previous analysis were a subset of these results. At the grade 4-5 level, only the Chi-square for the item CUPBOARD indicated a significant relationship (p=0.0174) between spelling group and a HIGH score for morpheme recognition. At the grade 6-7 level, three items yielded significant results: KNOWLEDGE (p=0.0076), CUPBOARD (p=0.0003) and

DRAWER (p=0.0352). The items NECKLACE and DRAWER at the grade 4-5 level and DISCUSSION at the 6-7 level had previously been identified in the t-tests which used the same information (point system of scoring MR data). In this analysis, these items were significant only before Yates correction. Although they failed to reach significance after the correction for low expected cell frequencies, their crosstabulations give important information. Each of these three words had reasonably equivalent numbers of S and D subjects. In the case of NECKLACE and DRAWER, it is clear that only subjects in the S group received high scores; no D subjects received a high score. However, the overwhelming majority of the subjects had low scores for MR throughout. High scores, therefore, are predictably identified with S subjects for these items but no parallel predictions can be made concerning low scores. The crosstabs table for the item DISCUSSION showed that the majority of subjects received a high score for MR regardless of group. More than three times as many D subjects received low scores compared to those of the S group, but the differences were not significant .

In light of the results of the previous three analyses and in order to overcome the problem associated with the point system of scoring the MR data, it was decided to further utilize the information available in the profiles. The goal was to identify various types or combinations of responses which were closely associated with either the S or D groups for at least some of the items. The first step taken toward this end was to generate a crosstabs table which displayed the profiles which occurred and their frequencies in each group (S/D) for each of the items in the stimulus sets. While this was of some use, it was apparent that a more focused approach had to be taken. The next step was to determine how many of the possible 64 profile patterns actually occurred at each level and how frequent these patterns were. This information is summarized in Table 1. From this information it can be seen that, of the possible 64 profiles, 25 actually occur in the data base and of these 25 profiles, only about 12 occur with sufficient frequency to be of real interest. These 12 account for 982 or 93% of the total cases and

TABLE 1. PROFILES WHICH OCCUR IN THE DATA BASE

PROFILE	FREQUENCY OF OCCURENCE		
	4,5	6,7	TOTAL
111111	21	64	85
111110	2	13	15
111100	1	-	1
110111	-	1	1
110110	2	2	4
110100	-	3	3
101111	9	41	50
101110	3	18	21
100111	2	3	5
100110	4	4	8
100100	2	1	3
011111	19	51	70
011110	10	14	24
010111	5	-	5
010110	5	8	13
010100	6	5	11
001111	50	46	96
001110	27	26	53
001100	11	6	17
001010	-	1	1
001000	-	2	2
000111	15	7	22
000110	76	35	111
000100	160	163	323
000000	98	14	112
TOTALS	528	528	1056

include all valid profiles with a total frequency of 15 or above.[10]

Once the occurring profiles were identified and their frequencies were enumerated, further analysis was possible. As a follow-up on the last statistical tests, the 25 profiles were divided into two groups according to whether the profile would be associated with a HIGH score or a LOW score as defined previously. Recall that the fourth column of the profiles is an explicit characterization of a response which is implicit in the point system. A HIGH score profile, then, would be one containing 4-6 positive responses. Any profile with three or less positive responses would be associated with a LOW score. The objective here was to determine if there was any reasonable way to characterize the profiles which were associated with HIGH or LOW scores. The HIGH and LOW score profiles are listed in Table 2 where * denotes an isolated case (or maximum of 2 cases).

TABLE 2. HIGH AND LOW SCORE PROFILES

HIGH (4-6)	LOW (0-3)
111111	110100
111110	100110
111100 *	100100
110111 *	010110
110110	010100
101111	001110
101110	001100
100111	001010 *
011111	001000 *
011110	000111
010111	000110
001111	000100
------	000000

An examination of Table 2 reveals that there are 12 profiles which would be associated with a HIGH score and 13 which would fall into the classification of a LOW score. With the exception of one isolated case, all the HIGH score profiles share an important characteristic; that is, the fourth and fifth columns indicate positive responses. These types of profiles indicate that the subject knew the root (Q4) and indicated that he thought the derived word "came from" the root (Q5) whether or not he suggested the root himself (Q3) or had thought of the relationship before (Q6). However, the list of LOW score profiles also contains five profiles with this characteristic. The next step, then, was to examine the groups S and D in terms of subject responses to Q4 and Q5.

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[10] Except 001100 (which involves a contradiction between the responses to the "CF" questions), where n=17.

Data were crosstabulated in terms of the groups S/D and the responses COMES FROM (CF) and DOESN'T COME FROM (NCF). A "CF" response here was defined as a positive response to Q5. That is, the subject thought the derived word "came from" the potential root regardless of who had suggested the "root" (the subject or the experimenter) or whether or not the relationship had been considered prior to the experiment. A "NCF" response was defined as a negative response to Q5. In either case, the fourth column must have contained a positive response. In other words, the subject had to have indicated that he knew the potential root in order to be considered part of the analysis. A "CF" profile, then, would be of the type xxx11x and a "NCF" profile would be characterized as xxx10x where the "x" indicates that responses are free to vary.

A Chi-square test was calculated for each item in order to determine if there was a significant relationship between spelling groups and morpheme recognition defined as a positive response to the second "Comes From" question (Q5). Significant results were obtained for the following items at the grade 4-5 level: CREATURE (p=.0412), CUPBOARD (p=.0033), and NECKLACE (p=.0098). The item SIGNAL narrowly missed significance at (p=.0530). At the grade 6-7 level, the following two items were identified: CUPBOARD (p=.0001) and DRAWER (p=.0006).

The next analysis in the study again utilized the information in the profiles but redefined the responses of interest. In this analysis, a "CF" response was defined as positive responses to both Q3 and Q5. A profile with these responses indicated that the subject had suggested the root in response to the first "Comes From" question (Q3) and had also confirmed his response (Q5), although he may or may not have thought of the relationship before (Q6). A "NCF" response was defined as a negative response to either or both questions. Again, only cases where the fourth column of the profile contained a positive response were selected for the analysis. In short, then, "CF "was any profile of the form xx111x while "NCF" was any of the profiles xx011x, xx110x, xx010x.

The results of this analysis identified the same items that previous analyses had identified as having significant relationships between spelling groups and MR responses. Of the grade 4-5 words, only the item CUPBOARD reached significance (p=.0250). The Chi-square tests for the grade 6-7 stimuli set identified the following items: DISCUSSION (p=.0098), KNOWLEDGE (p=.0076), CUPBOARD (p=.0024) and DRAWER (p=.0155).

An overall look at all the statistical analyses reveals that certain stimulus items are repeatedly identified as having significant relationships between the spelling groups and some definition of morpheme recognition. Many other items never show significant relationships, but various tabulations of the data indicate that both groups respond to the item in consistent ways (these cases will be discussed shortly). The significant results of the various analyses are summarized in Table 3. As noted, all levels of significance reported here are those attained after Yates correction. Note that, for the items which are common to both sets, the levels of significance increase from the grade 4-5 level to the grade 6-7 level.

Table 3. RESULTS OF ITEM ANALYSES

ITEMS	t-test	Y/N	H/L	CF=Q5	CF=Q3,Q5
GRADE 4-5					
Cupboard	0.000	0.046	0.017	0.003	0.025
Drawer	0.001				
Necklace	0.001			0.01	
Signal				(0.053)	
Creature				0.0412	
GRADE 6-7					
Cupboard	0.000	0.000	0.000	0.000	0.002
Drawer	0.000		0.035	0.001	0.016
Discussion	0.025				0.010
Knowledge	0.001		0.008		0.008

3.4.1.4 SUMMARY OF RESULTS (ITEM ANALYSES)

In addition to the information derived from statistical analyses, various manipulations of the data revealed information which was pertinent to the topic of morpheme recognition. One of the goals of the study was to develop some methodology—which could be used to address the question of whether potentially relatable words are, in fact, related psychologically by ordinary language learners. The remainder of this section gives some insights into how the stimulus items fared in this respect. A brief "picture" of each stimulus item is presented which is based upon a comprehensive view of all the statistical analyses, as well as observations from other compilations and manipulations of the data which will be indicated where relevant.

The experiment utilized a total of 19 stimulus items. Of this total, a few were essentially eliminated from grouping analysis when the spelling groups were re-defined as S and D. Crosstabs of the word CRIMINAL, for example, show that 43 of the 48 subjects fell into the S group, indicating that most subjects did not make critical spelling errors. Most subjects (regardless of group) scored one or several points for morpheme recognition on this word, although the overwhelming majority fell into the category "NO" when MR was given the strictest definition (positive responses to the last four MR questions). Although 14 profiles appeared for this word, the most common ones were 000110 and 001110, which indicate that the subjects responded positively to either or both of the "Comes From" questions but that the relationship with the word CRIME only occurred to them once it was brought to their attention in the context of the experiment.

The three items CAVITY, FABULOUS and VEGETABLE shared a common fate. Virtually all of the subjects fell into the S group of spellers and the overwhelming majority of subjects saw no relationship between these words and their potential roots. The highest "degree" of morpheme recognition resulted for the word CAVITY, where approximately 1/3 of the subjects had profiles which indicated that they thought CAVITY "came from" the word CAVE, but they hadn't thought about the possible relationship prior to being asked about it.

The word PRECIOUS was also treated somewhat similarily to FABULOUS, the other -ous item in the set. Although the S and D groups for this item were fairly close in number, there was little difference in the way the subjects responded to the MR questions. More than 2/3 of the subjects said that there was no relationship between the words. Although 13 of the 48 ventured a "maybe" or a "yes" in response to the second "Comes From" question (compared to only 2 for FABULOUS), none of the subjects had ever thought of the possibility of the relationship before.

There were two items for which morpheme recognition could not be "measured," since their potential roots were not known to the subjects. All profiles for the item PRESIDENT were of the form 000000 indicating that no subjects knew the meaning of the word PRESIDE. Any "morpheme recognition" which resulted for the item AWFUL and its "root" AWE was a clear case of educationally instilled knowledge, as all five subjects who were aware of a relationship between the words (001111) noted that they had learned about the word in their spelling book some weeks prior to the testing session. Of the 48 subjects, 42 claimed to never have heard of the word AWE and had no idea what it meant. A few subjects ventured to guess that perhaps AWFUL "came from" the expression "AW" (as in "Aw, I don't want to do that."), but prior to the experiment none of them had ever thought of the word as having a root sub-component.

The stimulus set for grades 6-7 contained four words with the suffix -(t)ion. These items yielded results that were parallel in many respects. Although the S/D groups for DISCUSSION and DECISION were very close to equal, POLLUTION and DESCRIPTION had almost twice as many subjects in the S group as in the D group. However, in all cases, both S and D were large enough for meaningful analysis in terms of groups. Between 10 and 12 profiles were associated with each of these items. All subjects in both groups received at least one, and generally several, points for morpheme recognition. In terms of the strictest definition of morpheme recognition, approximately twice as many subjects were scored YES as compared to NO and, in all cases, two-thirds or more of the subjects claimed to have been aware of the relationship between the derived word and its root prior to the experiment. Interestingly, the only item to show any statistically significant difference between the groups is the one where the root is completely contained orthographically within the derived word (DISCUSSION). Subjects in the S group tallied up a significantly larger number of points for morpheme recognition on this item and were also significantly more inclined to suggest the root DISCUSS in response to the first "Comes From" question.

The S and D groups responded in a similar manner to the item ELECTRICITY. Almost all the subjects received some points for morpheme recognition (System II), although subjects were very nearly equally divided in terms of the YES/NO definitions of MR. Practically all of the subjects (45 of the 48) thought that ELECTRICITY "came from" the word ELECTRIC (Q5), but only about 60% of the subjects claimed that they had thought of the relationship previously.

The stimulus item CREATURE yielded few MR points and the cross-tabulations show that only those in the S group received them. The results, however, are not significant in terms of the strict YES/NO definition of MR, since only two S subjects suggested the root CREATE and claimed to have thought of the relationship before; the overwhelming majority of the subjects did not see the words as being related. After the potential root was brought up by the examiner, however, S subjects were significantly ($p=.0412$) more inclined to think that CREATURE "came from" the word CREATE.

After the recoding of the spelling groups, the S group for the item KNOWLEDGE was comprised of 38 subjects compared to 7 in the D group. Most subjects, then, did not make critical misspellings of this item. While there was no significant difference between the groups in terms of strictly defined morpheme recognition (YES/NO), the S group tallied up significantly more points for MR and were also significantly ($p=.0076$) more inclined to suggest the root in response to Q3. Of the 15 profiles which occurred for this item, 12 have a frequency of three or less. The two profiles 111111 and 101111 accounted for more than half of the profiles in the S group. These subjects both suggested the root (Q3) and claimed to have been aware of the relationship prior to the experiment (Q6). Only one subject in the D group had a profile which indicated both of these responses. This suggests that, had the groups been more equal in number, there may have been a significant difference between the groups in terms of the YES/NO distinction. However, the main reason this distinction was not significant appears to be the fact that even the S group was fairly evenly divided in terms of the strictest definition of MR. Of the 38 S-group subjects, 21 were coded YES compared to 17 who were coded NO. Sixteen of these seventeen "NO" subjects lacked a positive response to Q6; that is, these subjects indicated that they had only thought about the relationship during the course of the experiment. While the S group seemed to be more inclined to be able to make the connection between the root and the derived word, the small number of subjects in the D group made it difficult to establish this statistically.

The data for the stimulus item NECKLACE show that the majority of the subjects (regardless of group) did not perceive a morpheme LACE in the word. The four subjects that received a YES for MR were members of the S group. The overwhelming majority of the D subjects are accounted for in the profile 000100, which shows that these subjects knew the potential root but saw no connection between it and the "compound" word. This profile accounts for about 1/3 of the S group. Most of the other profiles which occur belong exclusively to the S group. In the majority of these cases, the fifth column indicates a positive response. The statistics of the fourth analysis confirm that members of the S group are significantly more inclined to think that NECKLACE "comes from" the word LACE — at least once it is suggested to them by the experimenter.

The results for the item SIGNAL border on showing significant differences between the spelling groups. There were 35 subjects in the S group as compared to 13 in the D group. Various cross-tabulations of the data reveal certain tendencies but these either narrowly miss significance or are significant only before Yates correction. The S group is almost equally divided between the YES and NO definitions of MR. Only 2 of the D group score a YES but the differences between the groups are not significant, since the S group is so equally divided. The profiles show that only 2 of the D group subjects have thought of the relationship between SIGN and SIGNAL before, whereas about half of the S group claim prior knowledge. The fourth analysis which compares the responses of the two groups to Q5 approaches significance (p=.0530). This suggests that those who do not make critical spelling errors are more likely to think (or to accept the notion when it is suggested) that SIGNAL "comes from" the word SIGN.

There were three words which were used at all grade levels: MESSENGER, DRAWER, and CUPBOARD. The results for these items are consistent across the data base with some increase in significance from the 4-5 to the 6-7 grade level for the latter two items. In the case of the item MESSENGER, there were no significant differences between the spelling groups. At the 4-5 level, 26 of the 48 subjects scored a YES for morpheme recognition. At the grade 6-7 level this increases to 35 out of the 48.

The item DRAWER produced results similar to those of NECKLACE at the 4-5 level. Those few subjects who did score a YES for MR were from the S group. The S group also received more points for MR and account for twice as many of the profiles as the D group. Except for the t-test, however, the results of the analyses are not significant, since the majority of the subjects in both groups saw no relationship between the word DRAWER and its potential root DRAW. At the grade 6-7 level, however, these tendencies increase to levels of high significance. The results of the various analyses show that S subjects have significantly more high scores, a greater tendency to suggest the potential root and are significantly more inclined to believe that DRAWER "comes from" the word DRAW. It must be noted, however, that the majority of subjects were coded NO in terms of the strictest definition of morpheme recognition.

The item CUPBOARD yielded highly significant results for all analyses with the levels of significance increasing from the 4-5 to the 6-7 grade levels. This indicates that there are real differences in morpheme recognition between the groups. Any indications of MR were accounted for almost exclusively by the S group. At both levels, the majority of the D subjects were assigned the profile 000100, which shows that these subjects knew the word CUP but did not see it as having any relationship to CUPBOARD. The S subjects were much more inclined to believe that the two words were related. In terms of the strictest definition of MR, however, all D subjects and the majority of S subjects did not perceive the morpheme CUP in the word CUPBOARD.

3.4.2 UNGROUPED ANALYSES

The previous section has been concerned with analyzing the data in an item-by-item manner with respect to the reponses of the two spelling groups. This section addresses several general questions without regard to the grouping distinction. As in prior analyses, all the ungrouped analyses are necessarily item-by-item and there is no information here regarding within-subject responses. The basic concern in this section is with evaluating the systems of scoring the MR data and with probing relationships between positive and negative responses to some of the questions which were utilized in the MR task.

3.4.2.1 THE MR SCORING SYSTEMS

The first analysis outlined here was intended to clarify the relationship between the YES/NO scoring system for MR and the HIGH/LOW system. For each item in both stimulus sets a crosstabs table was computed. Chi-square tests on the crosstabs tables showed that the relationship between NO/LOW and YES/HIGH was highly significant for all cases where statistics were computed [11]. A clear pattern emerged in all tables: a LOW score cannot result in a YES response. Low scores, then, are predictably coded NO. The majority of HIGH scores are YES responses but NO/HIGH scores also occur, accounting overall for almost one quarter of the HIGH scores. These results indicate that the two systems overlap but are not equivalent. Since a NO/HIGH score occurs approximately one quarter of the time (although this differs considerably, of course, from item to item), the profile system should be utilized as it reduces the ambiguity of interpretation. While the YES/NO scoring system is probably the most valid in terms of defining "morpheme recognition", it does not allow the insights that can be revealed with manipulations of the information in the profiles. The profile system can be used to look at MR both in terms of the strictest definition (YES/NO) and in terms of various combinations of responses. The advantage of this system, then, is that it reveals significant information that would be obscured in a simple YES/NO system and allows the interpretation of the information which occurs in the point system of scoring MR data.

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[11] Statistics were not computed for the items PRESIDENT, PRECIOUS, VEGETABLE and FABULOUS since all responses were of the NO/LOW type.

3.4.2.2 THE "COMES FROM" QUESTIONS

Two analyses were conducted which utilized the information in the profiles in order to address questions pertinent to morpheme recognition and the "comes from" questioning technique. Each analysis was done on the data pertaining to the individual items in both stimulus sets. These analyses are representative of additional ways that the information in the profiles can be utilized.

The first question which was addressed concerned the correspondence of the Q5 responsese and the Q6 responses. This question could be formulated as follows: In general, were subjects who thought that the derived word "came from" the suggested "root" (positive response to Q5) more likely to have thought of the relationship before (positive response to Q6)? To address this question, a four-celled crosstabs table was used to enumerate all positive and negative responses to Q5 and Q6 for each item in the two sets. The SPSSx program which was used selected only those cases where the subject indicated that he knew the potential root (i.e., there was a "1" in the fourth column of the profile). When this condition was met, a number of stimuli lost observations as follows: AWFUL (42 cases), CREATURE (1), PRESIDENT (48), NECKLACE (3), DRAWER (9), and FABULOUS (12). When the Chi-squares for each stimulus item were computed, results fell into three categories: (1) There was a significant relationship between the second "comes from" question (Q5) and the recall question (Q6), (2) there was no significant relationship and the majority of subjects fell into one row or one column, or (3) statistics could not be computed.

In the first category, the following grade 4-5 items showed a significant relationship between Q5 and Q6: SIGNAL (p=.0006), CUPBOARD (.0069), NECKLACE (.0006) and DRAWER (.0282). In the grade 6-7 set, significant results were obtained for the items KNOWLEDGE (.0141), CUPBOARD (.0002), and DRAWER (.0282). For these items, then, subjects who thought the derived word came from a root tended to have thought of the relationship prior to the experiment. That is, those who responded positively to Q5 significantly tended to respond positively to Q6; those giving negative responses to Q5 always gave negative responses to Q6. This latter observation, incidentally, is true for all items, since no table shows a response which contained a negative Q5 and a positive Q6.

The results of categories (2) and (3) can be described together since the same patterns emerged. In these cases, all, or the majority of responses, fell into a single row or column in the crosstabs table. Two patterns appeared here. In the case of the items DISCUSSION, POLLUTION, ELECTRICITY, MESSENGER, CRIMINAL, DESCRIPTION and DECISION, subjects tended to agree that the derived word had the proffered root (positive response to Q5). These subjects, however, are divided as to whether they thought of the relationship previously (Q6). A second pattern appears for the items CREATURE, CAVITY, PRECIOUS, and FABULOUS. In these cases, subjects are divided on Q5 (whether the derived word had a separate root). All, or the majority of the subjects, however, had not thought of the relationship prior to the experiment. Several items did not fall into any of these categories. Only one subject thought that VEGETABLE might "come from" the word TABLE (no one had even considered the possibility before) and AWFUL and PRESIDENT were eliminated from the analysis as virtually no subjects knew the potential roots.

A second analysis utilizing virtually the same SPSSx program was performed to address a question concerning responses to Q3 and Q6. The question addressed here was as follows: Are subjects who suggest the "root" in response to the first "Comes From" question (Q3) more likely to have thought of the relationship before (Q6)? Again, the only cases selected for analysis were those where the subject indicated knowledge of the root (positive response in the fourth column of the profile). Crosstabs and Chi-squares were performed on each individual stimulus item and~~, as~~ before, all levels of significance reported are those obtained after Yates correction.

In this analysis, high levels of significance were found for more than half of the stimulus items. In the grade 4-5 set, the following items were significant at the .05 level: CRIMINAL (.0401), SIGNAL (.0000), CREATURE (.0258), CUPBOARD (.0166), ELECTRICITY (.0076), MESSENGER (.0001), CAVITY (.0000), and NECKLACE (.0014). At the grade 6-7 level, significant results were obtained for the items DISCUSSION (.0420), KNOWLEDGE (.0027), CUPBOARD (.0001), MESSENGER (.0141), DESCRIPTION (.0012), and DRAWER (.0035). The items which did not yield significant results exhibited similar patterns to those discussed for the previous analysis. In sum, then, these results show a strong relationship between the subject's suggesting the root and his previous perception of the derived word. Note that this stricter definition of MR which required that subjects come up with a root (if they thought there was one) identified more items than the previous analysis did. As well, in most cases the levels of significance are higher. In other words, positive responses to Q3 better correlated with positive responses to Q6 than did positive responses to Q5. This suggests that the first "Comes From" question (Q3) is more reliable in tapping subjects' MR knowledge than the second one (Q5), which has a stronger tendency to lead to responses which reflect the learning effect of the task. In an abbreviated test that did not use Q6, therefore, Q3 would be a better "CF" question to use than Q5.

3.4.2.3 BERKO'S MR QUESTION

Several analyses were conducted which were intended to explore the validity and efficiency of Berko's MR questioning technique with respect to the responses elicited with the other questions utilized in this MR task.

A first analysis probed the relationship between responses to Q1 (definition question) and Q2 (Berko's question). The definition question was originally included in the task as a check to ensure that subjects had some reasonable concept of the "derived" word's meaning before they were presented with the MR questions for that item. While it was clearly recognized that this type of question did not require the identification of morphological relationships, subjects were given a score of "1" if they used the putative "root" in the course of defining the derived word. The purpose of this analysis was to determine if there were items where positive and negative responses to the Berko question were significantly related to positive and negative responses to the definition question. The question addressed here, then, could be formulated as follows: for which items did the Definition question significantly tend to elicit the same types of responses (positive or negative) as the Berko question. To address this issue, a crosstabs table for each item was generated and Chi-square tests were performed on the tables. At the grade 4-5 level, the items SIGNAL ($p=.0097$) and MESSENGER ($p=.0029$) were identified. At the grade 6-7 level, there was a significant relationship between positive and negative responses for the items CUPBOARD (.0229) and MESSENGER (.0081). This suggests that, for these items, the two questions were equally "successful" or "unsuccessful" in eliciting what might be identified as "morpheme recognition" or an awareness of a relationship between the "root" and "derived" word. For the other items, there was no significant relationship between a subject's response to the two questions, although there were a number of words where statistics were not computed, since all responses fell into a single row on the table. For all of these items (PRECIOUS, VEGETABLE, FABULOUS, DRAWER, CAVITY and NECKLACE) the pattern was the same: no subject scored a positive response to Q1 and the majority of responses to Q2 were also negative. In these cases, then, Berko's question was slightly more "successful" than the Definition question, which did not elicit any responses containing the putative "roots."

Two more analyses were conducted to investigate the relationships of the Definition question and the Berko question, respectively, to the strictest definition of MR (positive responses to the last four questions). The question for investigation here is as follows: Do subjects who score a YES for MR tend to respond positively to either the

Definition question or the Berko question for any particular items? The two analyses utilized the same SPSSx program but with the focus on only the first and second columns of the profiles changing. Only cases where the potential root was known were selected for the analysis. Cross-tabulations were computed to enumerate positive and negative responses to the Definition and Berko questions vs. YES and NO definitions of MR for each item in both sets. Chi-square tests were then conducted on these tables.

These analyses yielded few significant results. When the focus was on the Definition question, only the items MESSENGER (p=.0009) and KNOWLEDGE (p=.0048) showed a significant relationship. When positive and negative responses to the Berko question were tabulated with YES/NO responses, the items MESSENGER (p=.0006) and CAVITY (.0205) were identified at the 4-5 level. The latter statistic is based on only two cases of MR defined as a profile of the form xx1111. At the 6-7 level, only the item CUPBOARD (p=.0279) was identified.

These results show that there is a very poor correlation between the "positive" responses elicited by Berko's MR question and the YES responses for all items except MESSENGER. At the grade 4-5 level, all items (except MESSENGER) had more NO responses than YES responses. At the grade 6-7 level, however, there were a number of items where the YES responses substantially outnumbered the NO responses. These items were DISCUSSION, POLLUTION, MESSENGER, DECISION, and DESCRIPTION (KNOWLEDGE was fairly equally divided between YES and NO). There was no significant relationship between subjects' responses to the Berko question and their responses to the last four MR questions for these items. This result could be partly due to the properties of the stimulus items. That is, the nouns ending with the -(t)ion suffix do not seem to "fit" as well into the Berko frame as some other nouns might and subjects may have been more inclined to perceive these questions as being somewhat "strange" (e.g., "Why is a DESCRIPTION called a DESCRIPTION?"). Note that Berko herself used this frame only for (historical) compound words where an etymological response would clearly be appropriate. In general, the Berko question did seem to elicit a variety of types of responses including a greater number of "I don't know" types of responses than any other question. These results concur with the earlier finding of Derwing (1976) that the Berko technique is not a generally valid one for probing subjects' knowledge of derivational relationships.

4. CONCLUSIONS

4.1 SUMMARY OF RESULTS AND DISCUSSION

This study had a dual objective and, hence, conclusions can be drawn with respect to the various analyses pertaining to each objective. One purpose of this thesis was to present and explore an "enhanced" method for probing and assessing morpheme recognition, or the perception of morphological relationships between various "roots" and "derived" words. The results of the analyses pertaining to this objective lead to several clear conclusions.

Firstly, as described in Section 3.4.2.3, it was found that Berko's MR question was not a valid technique for assessing knowledge of derivational relationships, confirming Derwing's (1976) conclusion that it "allows for far too much variety in the types of responses which it can quite sensibly elicit" and that a subject's failure to provide an appropriate etymological response is not necessarily "indicative of his lack of cognizance of morphological relationships" (p.50). In addition to these shortcomings, it was also found that the Berko technique was of limited usefulness since it did not accomodate a wide variety of derivational constructions. Etymological compounds fit most naturally into the Berko frame while other derived words produce questions which subjects may find more or less "natural" or "unnatural". The word MESSENGER, for example, seemed to fit well into the Berko frame and the resulting question elicited many "positive" responses. Other items, such as those containing the -(t)ion suffix, however, produced much less "natural" questions. Analyses showed that there was no relationship between subjects' responses to the Berko question and their responses to the other MR questions, even though the YES responses substantially outnumbered the NO responses for these items. It seems clear, then, that the Berko technique is both limited in its applicability and untrustworthy even when clearly applicable.

Several analyses were devoted to assessing the other techniques for "measuring" morpheme recognition which were presented/utilized in this study and the various systems for scoring the kind of data elicited by these techniques. Of the three systems which were devised to score the MR data, the profile system was found to be by far the most useful and versatile. While the MR information is contained in the point system of scoring, it was found that this information was essentially uninterpretable except in the vague sense of "degree" of morpheme recognition. The main problem with this system was that HIGH scores were not necessarily identified with cases of qualified morpheme recognition. Although a LOW score predictably indicated that no morphological relationship had been perceived, a HIGH score did not necessarily lead to the opposite conclusion, since NO/HIGH scores accounted for approximately one quarter of all HIGH scores. The simple YES/NO scoring system (System I) was found to be equivalent to the profile definition of YES as a positive response to the last four MR questions vs. all other profiles. It was concluded that this "strict" definition of morpheme recognition was probably the most valid in terms of identifying clear cases of MR, but that significant information was obscured in this simple clear-cut system. In particular, significantly different types of responses between the spelling groups were revealed only with manipulations of the profile system.

Two "Comes From" questions were utilized in this MR task. In addition to Derwing's (1976) original CF question, another CF question was implemented which required subjects to identify the potential root if they thought the derived word "came from" a root. This CF question proved to be the more valid of the two, since positive responses to Q3 better correlated with positive responses to Q6 than did positive responses to Q5. In other words, subjects who suggested the root themselves (for any particular item) were more likely to have considered the relationship prior to the experiment, whereas the second CF question was more prone to lead to responses which reflected the learning effect of the task (positive responses to Q5 and negative responses to Q6). This result was foreshadowed in Derwing's (1976) MR study where it was found that "subjects showed a bias in the direction of *accepting* a specific, proposed morphological relationship, even though they might never have considered the possibility on their own in any of their prior linguistic experience" (p.53). An additional interesting finding of this experiment was that these types of responses were associated (for many items) solely or primarily with subjects whose critical spellings of the root and derived word corresponded. In other words, when the possibility of the relationship was suggested to the subjects, knowledge of the spelling was utilized in order to decide if the two words were related. While this was obviously not the sole or primary basis of all MR judgements, there were some definite differences in the way the spelling groups responded to some stimulus items. This leads to a consideration of the findings associated with the second objective of this study.

This objective was to examine the extent to which the ability to recognize morphemes in "derived" words is correlated or associated with the ability to spell these words. The results of this study support the conclusion that, depending on the nature of the stimulus item, knowledge of the spelling can be an important contributor to "morpheme recognition." While knowledge of spelling alone is clearly not a reliable indicator of MR, this knowledge may make the awareness of some derivational relationships possible. In effect, literacy and educational experience may lead to an increased capacity for morphological awareness. The results of this study give several clear indicators that this may be the case and, on the basis of this research, several conclusions can be put forth.

Derwing (1976) suggests that one of the main unanswered questions in derivational morphology concerns the comparison of the linguists' analytic proclivities with those of the ordinary language learner? The results noted here, especially as seen in the light of previous studies, suggest that there is considerable discrepancy between the type of analysis done by the "ordinary language learner" and the linguist, although the gap may be bridged somewhat by the attainment of literacy and educational experience. As Derwing argued, the evidence to date suggests that language learners do learn some morphological generalizations. The types of generalizations which they learn, however, are likely to be based on cases where both the semantic and phonetic similarities between the forms are obvious and the affixes are regular and highly productive (as in the cases of *teach-teacher, quiet-quietly, dirt-dirty,* etc.). As well, noun compounds (such as *birdhouse*) may be especially amenable to morphological analysis (see Derwing and Baker,1979). Beyond these fairly "obvious" cases however, there is little empirical evidence that the morphological awareness of the average speaker anywhere approximates the "linguist's penchant for detailed morphemic analysis." This study has provided evidence that many formally related words are, in fact, thought to be unrelated by the average speaker-hearer and that awareness of morphological relationships is enhanced (sometimes determined) by educationally derived knowledge such as knowledge of particular spellings.

Of course, as already noted, knowledge of spellings is obviously not the most important factor in morpheme recognition. As is commonly supposed (and as supported by prior investigations), the psychological recognition of morphological relatedness is critically dependent upon the degree of semantic and phonetic similarity of the word pairs involved, and of these two independent variables, semantic similarity is easily the more important. The average speaker-hearer does not perceive morphological relationships between pairs like *ham-hammer* where there is clear phonological and orthographic similarity but no semantic connection. For example, in this study no subject believed that VEGETABLE came from the root TABLE and even the historically related pair AWE-AWFUL had no apparent morphological connection for the subjects. Only those few who had been receptive to specific educational instruction were able to make the connection between these words; in fact, most of the subjects had no idea what the word AWE meant and certainly had not analyzed AWFUL into a root plus an affix -ful .

Although the semantic relationship is the most important variable in morpheme recognition, this study has provided evidence that the semantic connection can be critically tied to orthographic similarity. If a phonological discrepancy disguises the semantic connection, or if the synchronic meaning of the words bears little relationship to the historical connection, orthographic similarity may be necessary to establish a semantic link. Of course, speakers are not likely to depend solely on this knowledge since the English orthographic system appears to be largely a phoneme-grapheme code which does not reliably preserve lexical identity. Nevetheless, knowledge of particular spellings apears to be one source of morphological knowledge. If the orthographic evidence is clear and the synchronic semantic relationship is not obscure, literate speakers are likely to accept the possibility of a morphological relationship when it is suggested to them, even if they did not discover it themselves in their prior linguistic experience. This was clearly the case with the historically related pairs DRAW-DRAWER and LACE-NECKLACE in this study. For these word pairs, statistically significant differences were obtained between the spelling groups for various definitions of morpheme recognition. While the majority of subjects were coded NO in terms of the strictest definition of morpheme recognition, those few subjects who did score a YES were invariably from the S group. When the potential root was suggested by the examiner, S-group subjects were significantly more inclined to believe that the derived word "came from" the suggested root. These tendencies can be found in the cross-tabulations for a number of other items (i.e., CREATURE, SIGNAL, KNOWLEDGE). While the statistical results for these items were not always significant, it does seem suspicious that the tendency is always in the same direction. That is, any positive indications of MR are associated with the S group while the members of the D group never find any reason to associate the formally related words.

In addition to making awareness of morphological relationships possible, learning the spelling of words may actively contribute to the phenomena of "morpheme recognition." This seemed to be the case with the historical compound CUPBOARD. The fact that both historical roots are clearly represented in the spelling may make this relationship more "transparent" to the speller than is the case with other constructions, where the status of an affix may be questionable. Of course, perception of synchronic semantic similarity was the strongest factor in the MR judgements and even the majority of the spellers did not perceive the morpheme CUP in the word CUPBOARD in terms of the strictest definition of MR. For all statistical analyses, however, there were highly significant differences in the MR perceptions of the two groups and invariably it was the spellers who made the connection between the two words. Many of the comments of these subjects also indicated that their knowledge of the morphological relationship was a consequence of knowing how the derived word was spelled. A number of subjects suggested that this was a compound word and that it probably originated because "cups" were put on a "board," but then people "got lazy" and did not pronounce it like cup+board. Other subjects pointed out that the word was spelled cup+board and, therefore, probably "came from" these words because a cupboard was "made of boards" and "you put cups in it." One subject explicitly stated that he wondered why it was spelled with "p" so he looked it up in the dictionary and found it "came from" the words *cup* and *board*. For these subjects, then, morphological awareness was clearly a consequence of learning the spelling of the word. Subjects who could not spell CUPBOARD did not make these kinds of comments and, at both levels, the majority of the D subjects were assigned the profile 000100, which indicates that these subjects knew the word CUP but did not see it as having any relationship to CUPBOARD. In general, the D subjects for the item CUPBOARD, like the D subjects for the items listed above, appeared genuinely baffled as to why the experimenter would suggest such an unlikely relationship between two words, while the S subjects who had not already made the connection themselves were more inclined to exhibit what might be called "the eureka phenomenon." In quantitative terms, this means that the spellers tended to accept the possible relationship (Q5) even if it never occurred to them before (Q6), while the D group subjects found no reason to respond positively to either question.

Another observation which points to differences in MR between the two groups is that, for a number of items, the S group accounted for many more types of profiles than did the D group (see Section 3.4.1.4). While these profiles did not necessarily correspond to what was measured as "morpheme recogniton," they did suggest that the spellers had different cognitive associations for these items than the non-spellers did (or at least that the possibility for different associations was there). Consider the following conversation between the experimenter and a seventh grade speller of the stimulus item CUPBOARD (110100).

E: What does the word *cupboard* mean to you?

S: It's a little "room" that contains cups and dishes.

E: Why do you think a *cupboard* is called a *cupboard*?

S: (smile) 'cause it's a place where cups board.

E: Does the word *cupboard* "come from" any word that you know of?

S: No.

E: Do you know the word *cup*?

S: Well... yeah [as if to say "of course"].

E: Do you think that the word *cupboard* comes from the word *cup*?

S: uh... Nah.

This subject has clearly capitalized on the orthographic information but is not convinced that this information is a sufficient basis for establishing a morphological relationship between the words, since the synchronic semantic relationship is somewhat strained.

There were a number of stimulus items for which there were no apparent differences in MR between the two groups (i.e. both responded to these items in similiar ways). Two basic types of responses can be identified for these items: (1) The subjects (regardless of group) saw no relationship between the "derived" word and its putative "root" (CAVITY, FABULOUS, PRECIOUS, VEGETABLE; PRESIDENT and AWFUL were essentially eliminated from the analysis since their potential roots were generally not known to the subjects); (2) The subjects (regardless of group) tended to agree that the derived word had a "root," although they may or may not have thought of the relationship prior to the experiment (CRIMINAL, SIGNAL, MESSENGER, ELECTRICITY, DISCUSSION, DECISION, POLLUTION, and DESCRIPTION). With respect to these items and the types of responses which they elicited, a few pertinent observations can be made.

In the first category, the item VEGETABLE was a control item. The results indicate that spelling alone (in absence of a possible semantic connection) was not used as basis for a morphological connection between word pairs. An obscure semantic connection is more likely to be accessible, however, if the orthographic evidence is clear. Note that the responses for the items NECKLACE and DRAWER (and, to some degree, CREATURE) showed some differences between the groups, with the spellers being more successful at making a semantic connection. In the items CAVITY, FABULOUS, and PRECIOUS, however, the orthographic evidence is tenuous and the semantic connection appears totally obscure to both groups. There is no doubt that for the majority (if not all) of the subjects these "derived" words are not seen to be related to the roots in question. This evidence speaks strongly against the generative phonologists' assumption that there is some synchronic relationship between such historically related words, and hence the formal account of a single common lexical representation is highly questionable in these cases. It is clear, for example, that these subjects saw no relationship between the historically related pair FABLE and FABULOUS and, hence, could not possibly have abstracted a rule from such "data" as Chomsky and Halle suggest (1968:196) (cf. Derwing 1973:122).

For a second group of items, subjects (regardless of group) were inclined to agree that the derived word "came from" the putative "root," although they had not necessarily considered the possibility of the relationship prior to the experiment. This result, however, cannot be taken to indicate that the knowledge of these morphological relationships was gained solely with exposure to the spoken language and that educationally derived knowledge (such as knowledge of the spelling) played no role whatsoever here. There are several reasons for suspecting that these factors are of some importance here, as well. All the items which were treated in this manner (CRIMINAL, SIGNAL, MESSENGER, ELECTRICITY, DISCUSSION, DECISION, POLLUTION, and DESCRIPTION) have a reasonably strong (synchronic) semantic relationship to their putative roots, although the degrees of phonological and orthographic similarity vary somewhat. It is interesting to note that for two words where the orthographic evidence is clear (SIGNAL and DISCUSSION), several statistical analyses bordered on significant differences between the groups (see Section 3.4.1.4). For the most part, however, the strong semantic relationship seems to be the determining factor — although even this is not enough to make the connection between the words. The profiles for the item CRIMINAL, for example, show that most of the subjects responded positively to either or both of the "comes from" questions, but that they had never considered the relationship prior to the experiment. This is quite possibly due to the phonological discrepancy between the root and derived word and the possibility that the suffix -al is not very productive for these subjects. These subjects no doubt have a number of words in their vocabulary which end in -al and have no apparent separable root (e.g., *royal, loyal, oral, capital*) and this may influence the perception of these "derived" -al words.

The word MESSENGER was the only one of these items to be presented at all grade levels. The results show that, although there is no difference between the groups at any level, the degree of "morpheme recognition" for this item increases from the 4-5 to the 6-7 grade level. This may be indicative of educational experience as a significant factor in the ability to recognize morphological relationships between words.

The words containing the -(t)ion suffix were all used at the grade 6-7 level only. There were no significant differences between the groups (except in the case of the item DISCUSSION) and, in all cases, two-thirds or more of the subjects claimed to have been aware of the relationship between the derived word and its root prior to the experiment. An examination of the misspellings of these words shows that, whatever may have been the cause of the error, all attempts to spell these words end in either -tion or -ion rather than the phonetically plausible -shen or -shun. This may suggest that subjects have some awareness of -(t)ion as an affix and, hence, the potential for "morpheme recognition" is increased. Note that, in spite of the strong semantic relationship and the fact that all spellings and misspellings ended in -(t)ion, there were still almost a third of the subjects who indicated that their awareness of a relationship between the derived word and its root arose during the course of the experiment. It seems clear then, that many words formally related by linguists are not psychologically related for the average speaker-hearer and that awareness of derivational relationships is greatly enhanced with educationally derived knowledge, particularily knowledge of the orthographic structure of words.

Although this thesis was not concerned with the role of derivational knowledge in spelling productions, there is some evidence that there is some relationship here as well. A cursory examination of the misspellings collected in Task I of this study yielded the following interesting spelling attempts: numberous, clearity, wisedom, describtion, sheepered, messager, and pronounciation. As predicted by Simon and Simon (see Section 2.3.4), however, these "morphological" spellings accounted for very few of the misspellings, although the latter two were not uncommon. While this study does not provide empirical support for the speculation, it is possible that these misspellings are a consequence of morphological awareness. Subjects may be aware that the English orthographic system is not simply a phoneme-grapheme code, but also codes some important lexical information, and these errors may illustrate this awareness. The resolution of this question, however, is tangential to the central concerns of this thesis and was not further explored.

4.2 LIMITATIONS OF THE STUDY AND IMPLICATIONS FOR FUTURE RESEARCH

There are a number of inherent limitations in this research due to the exploratory nature of the study. A first and most obvious difficulty is the very small number of stimulus items which were utilized in the MR task. In addition, these items were essentially selected on the basis of the availability of correct and incorrect spelling responses so that, beyond being selected as potential candidates to begin with, there was no control over which items subjects were presented with. Out of a total of 19 stimulus items eventually used, only three were presented at all grade levels. Within the two sets of stimulus items, morever, a number of words were essentially eliminated from the grouped analyses when the spelling groups were redefined. In effect, the multi-dimensional problem of selecting subjects and stimuli for the MR task imposed some severe restrictions on the number of items which could be utilized. This problem was further complicated by redefining the spelling groups at the analysis stage, which resulted in a situation of unequal numbers of subjects in the groups for the various items. As a consequence, this study attempts to investigate an extremely complex phenomenon using a very small set of stimulus items and small subject samples (This was necessary because the MR task was rather elaborate and time-consuming). In light of these limitations, it must be recognized that these results are perhaps more suggestive than conclusive. However, the very high levels of significance which were obtained for some items in various of the analyses indicates that knowledge of a word's spelling may nonetheless be an important factor in "morpheme recognition" in general.

A second possibly "limiting" aspect of this study is the fact that subjects were asked to produce spellings during the MR task. Although subjects were asked all MR questions for each item before they were asked to spell the words, this aspect of the task may at some point have influenced subjects to focus on orthographic knowledge in making their morpheme judgements. In future investigations, all reference to spellings should possibly be removed from the MR task, although this would require that the spellings of the "root" words be elicited some time prior to the MR questioning. The problem with this, of course, is that subjects were also asked to spell the "derived" words prior to the MR task, and care would have to be taken to ensure that the presentation of the "roots" and "derived" words did not lead to a "learning" situation for the subjects.

As a consequence of the design of the experiment, there is no information in this study concerning within-subject~~-respons~~es. This raises the question of individual differences and the possibility that different subjects may utilize different "strategies" when confronted with the stimulus items. Although this question cannot be addressed within the design of this experiment, it should be noted that this would be a very complex problem to address. In the first place, it must be recognized that the stimulus items cannot be regarded as tokens of the same type. The way in which any particular subject responds to a stimulus item is likely to be influenced by a number of factors including the nature of the stimulus item itself, as well as subject specific variables such as prior exposure, intelligence, reading/spelling ability, etc.. It is far from clear, then, how an experiment of this nature would address the question of individual strategies, since the overall picture is likely to be extremely complicated. It is perfectly possible that any particular subject is utilizing a number of different "strategies" depending on the nature of the stimulus item and it would be no easy task to sort out the various contributions to any particular set of responses. This, then, is a topic which is far beyond the scope of this "preliminary probe" into a complex area of linguistic knowledge.

4.3 CONCLUSION

The results of the experimental study discussed in Chapter Three suggest that educationally derived knowledge (such as knowledge of a word's spelling) can be an important factor in the ability to analyze words morphologically. This knowledge appears to be more critical for some items than for others. While an awareness of the relationship between some words may be pre-literate knowledge, there is evidence that orthographic information is utilized as the phonological and semantic relationships become less clear. For example, the relationship between pairs like *sing-singer* is likely to be realized in pre-literate language acquisition since there is a clear semantic relationship, little phonological change and a highly productive affix. At the other end of the spectrum are words like *cupboard* and *handkerchief*, where awareness of the component morphemes is likely to arise (if it arises at all) only when the spelling is learned. In between these two extremes there appears to be a vast middle ground comprised of pairs like *sign-signal*, where the phonological and semantic relationships are less than transparent. In addition, the relationship between pairs like these may be obscured because the affix is unproductive or because there are competing forms where there is no morphological analysis called for at all (such as with a word like *capital*).

In any event, this study has provided evidence that subjects do make use of orthographic information in analyzing words morphologically, although knowledge of the spelling will not necessarily lead to the perception of a relationship if there is not a reasonably accessible (synchronic) semantic relationship. In effect, knowing the spelling of the word may make morphological analysis possible for some items, but it is likely that many words thought to be morphologically related by linguists are not so related or analyzed by the average speaker. Further empirical investigation and more refined methodological tools will be required in order to sort out the various sources of speakers' morphological knowledge and to determine the extent to which speakers actually engage in morphological analysis. Without this empirical basis, the impressive formal models which relate words by means of various rules will remain nothing but a convenient (if brilliant) fiction which bears little relationship to the linguistic knowledge of the average speaker-hearer.

5. BIBLIOGRAPHY

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6. APPENDICES

APPENDIX A: LIST OF 60 STIMULUS ITEMS

astound	astonish	know	knowledge
author	authority	lace	necklace
awe	awful	law	lawyer
bash	bashful	louse	lousy
break	breakfast	message	messenger
cave	cavity	moon	month
clear	clarity	muscle	muscular
courage	courageous	nation	nationality
create	creature	nature	natural
crime	criminal	number	numerous
crumb	crumble	origin	original
cup	cupboard	person	personality
decide	decision	please	pleasure
describe	description	pollute	pollution
destroy	destruction	preside	president
discuss	discussion	price	precious
draw	drawer	produce	production
ear	eerie	profess	professor
electric	electricity	pronounce	pronunciation
equate	equation	public	publicity
fable	fabulous	reduce	reduction
fry	Friday	right	righteous
gorge	gorgeous	sign	signal
hand	handkerchief	sting	stingy
hand	handle	table	vegetable
heal	health	wall	wallet
heave	heavy	wild	wilderness
herd	shepherd	wise	wisdom
hide	hideous	wonder	wonderful
hunger	hungry	young	youth

APPENDIX B: SPELLING RESPONSE SHEET - TASK 1

NAME:______________________ DATE:______________

AGE:______________________ GRADE:______________

SCHOOL:______________________________________

Spellings	Meanings YES	Meanings NO	Spellings	Meanings YES	Meanings NO
1.			16.		
2.			17.		
3.			18..		
4.			19.		
5.			20.		
6.			21.		
7.			22.		
8.			23.		
9.			24.		
10.			25.		
11.			26.		
12.			27.		
13.			28.		
14.			29.		
15.			30.		

APPENDIX C: FORTRAN PROGRAM FOR DISTANCE COMPUTATION

```
      DIMENSION DIST(1770), IDN(60)
      CHARACTER*1 IN(60), MAT(60,60), TITLE(80), WVEC(60)
      NI=21
      NC=0
      READ(5,4)TITLE
      WRITE(9,4)TITLE
   30 NC=NC+1
      READ(8,1,END=35) IDN(NC), (MAT(NC,J),J=1,NI)
      GO TO 30
   35 NP=0
      NC=NC-1
      DO 45 I=2,NC
      L=I-1
      DO 45 J=1,L
      NW=0
      NMM=0
      NP=NP+1
      DO 37 K=1,NI
   37 WVEC(K)='X'
      DO 40 K=1,NI
      IF(MAT(I,K) .EQ. 'C' .OR. MAT(J,K) .EQ. 'C') THEN
               GO TO 40
         ELSE
               NW=NW+1
               WVEC(K)='V'
               IF(MAT(I,K) .NE. MAT(J,K)) NMM=NMM+1
               IF(MAT(I,K) .NE. MAT(J,K)) WVEC(K)='M'
      ENDIF
   40 CONTINUE
      XM=NMM
      XW=NW
      DIST(NP)=SQRT(XM/XW)
   45 WRITE(9,2) I, J, IDN(I), IDN(J), DIST(NP), NW, (WVEC(K),K=1,NI)
      WRITE(6,3) NC, NP
      STOP
    1 FORMAT(4X,I4,2X,60A2)
    2 FORMAT(2I4,2X,2I5,2X,F7.3,3X,I4,3X,21A2)
    3 FORMAT('0','NO. CASES =',I3,'  NO. DIST. =',I5)
    4 FORMAT(80A1)
      END
End of file
```

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APPENDIX D: TABULATION CHART (EXAMPLE)

Subject Pairs	Grade 4: 27 Potential Stimulus Items																										
	1	2	3	5	6	9	10	14	15	20	22	23	24	31	32	34	35	36	39	41	47	50	51	53	55	56	58
26 - 13	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓	✓	✓	✓	✓	✓	✓	✓
55 - 34	✓	✓	✓	—	✓	—	✓	✓	✓	—	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓
51 - 8	✓	—	✓	—	✓	—	✓	✓	✓	✓	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	—	✓	✓	✓
57 - 60	✓	✓	✓	—	✓	✓	—	—	✓	—	—	✓	—	✓	✓	—	—	✓	—	—	✓	✓	—	✓	✓	✓	✓
19 - 10	—	✓	✓	✓	—	✓	✓	✓	✓	✓	—	✓	✓	✓	—	✓	✓	✓	—	✓	✓	—	✓	✓	—	—	—
41 - 14	—	✓	—	✓	—	✓	✓	—	—	✓	✓	—	✓	✓	✓	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
11 - 8	—	—	✓	✓	—	✓	✓	✓	✓	—	—	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	✓	✓	✓	—
37 - 25	✓	✓	—	—	✓	—	✓	✓	✓	✓	✓	—	✓	*✓	✓	—	✓	✓	✓	—	*✓	✓	—	✓	—	✓	—
48 - 3	✓	—	✓	✓	✓	✓	*✓	✓		✓	✓	✓	*✓	✓	*✓	✓	—	*✓	✓	—	—	—	✓	*✓	—	*✓	✓
31 - 4	✓	—	*✓	—	✓	—	✓	—	—	—	—	✓	✓	✓	✓	—	—	✓	—	✓	—	—	—	—	—	✓	—
49 - 28	*✓	—	—	✓	*✓	—	—	*✓	—	—	—	*✓	✓	—	—	—	—	✓	—	—	✓	✓	*✓	✓	—	✓	✓
40 - 9	✓	—	—	✓	✓	—	—	✓	✓	✓	✓	✓	—	—	✓	—	—	—	—	*✓	✓	—	✓	—	✓	✓	*✓

* indicates criterion of 8 mismatches

APPENDIX E: MR RESPONSE SHEET

Subject I.D. # Name (Last, First) - Sex - Age - School - Grade

CRIMINAL (CRIME)

Q1. Def.
Q2. Berko
Q3. CF1
Q4. Root
Q5. CF2
Q6. Recall

AWFUL (AWE)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

SIGNAL (SIGN)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

CREATURE (CREATE)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

PRESIDENT (PRESIDE)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

CUPBOARD (CUP)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

ELECTRICITY (ELECTRIC)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

MESSENGER (MESSAGE)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

CAVITY (CAVE)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

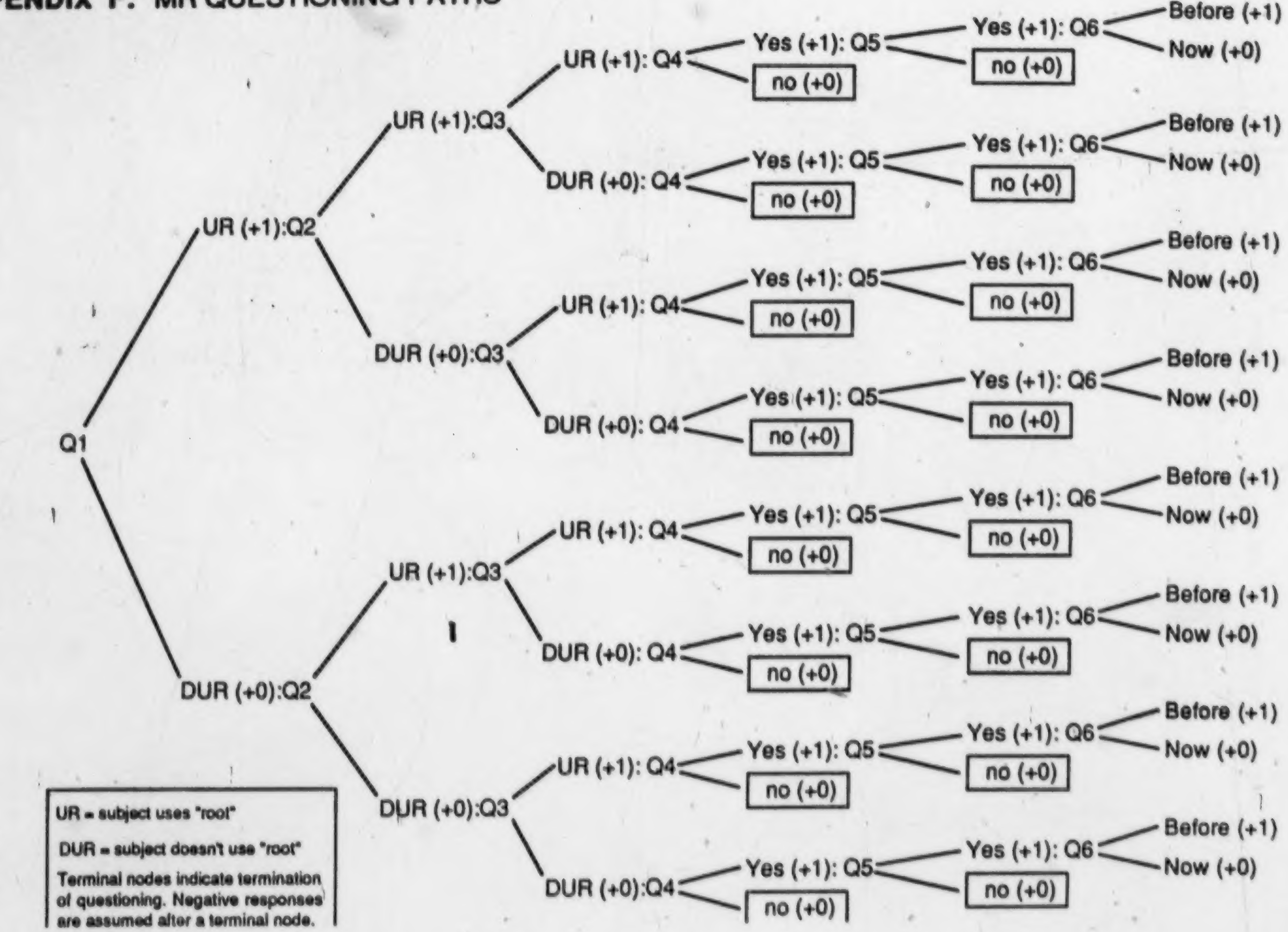
NECKLACE (LACE)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

DRAWER (DRAW)

Q1.
Q2.
Q3.
Q4.
Q5.
Q6.

APPENDIX F: MR QUESTIONING PATHS



UR = subject uses "root"

DUR = subject doesn't use "root"

Terminal nodes indicate termination of questioning. Negative responses are assumed after a terminal node.